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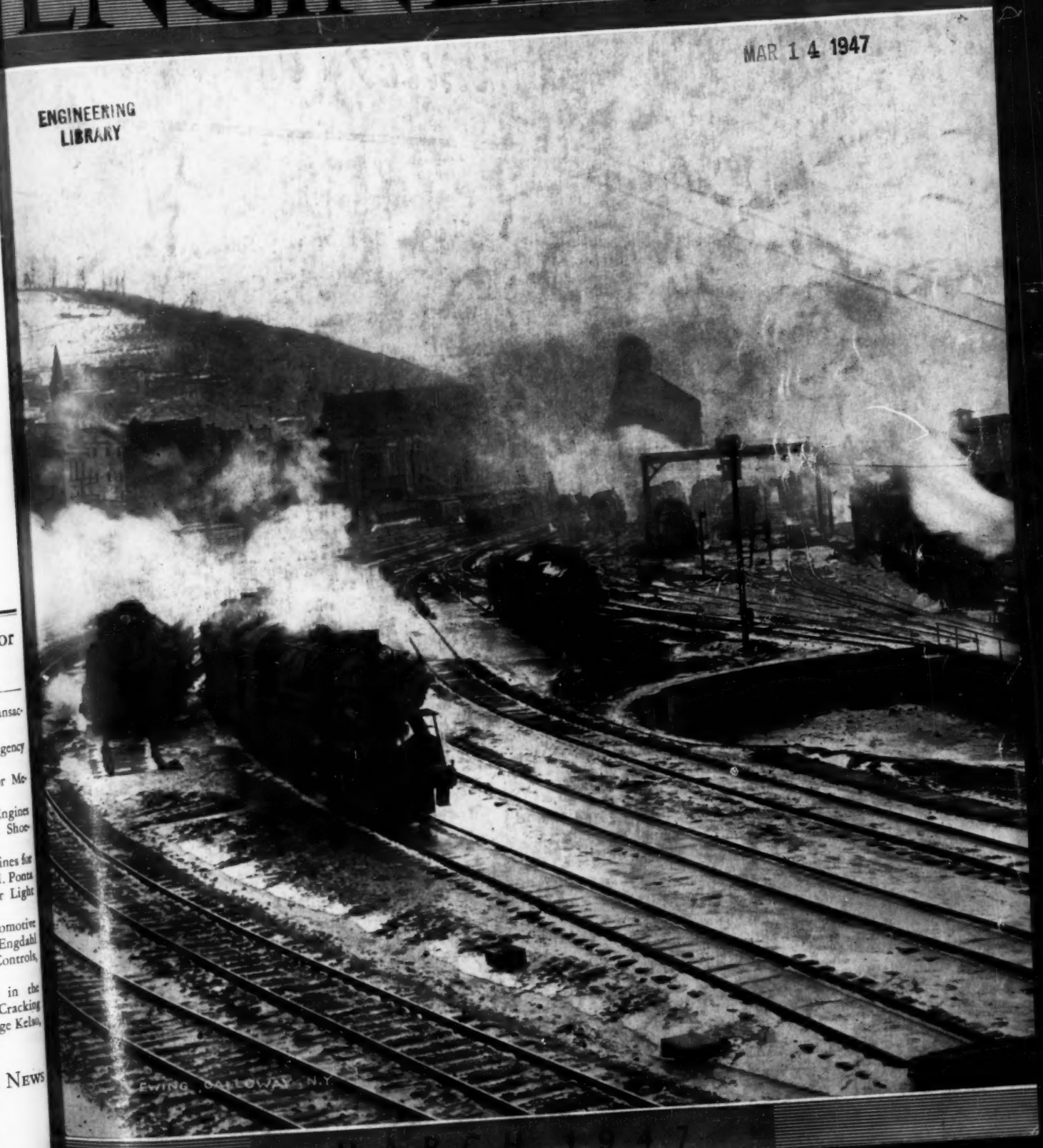

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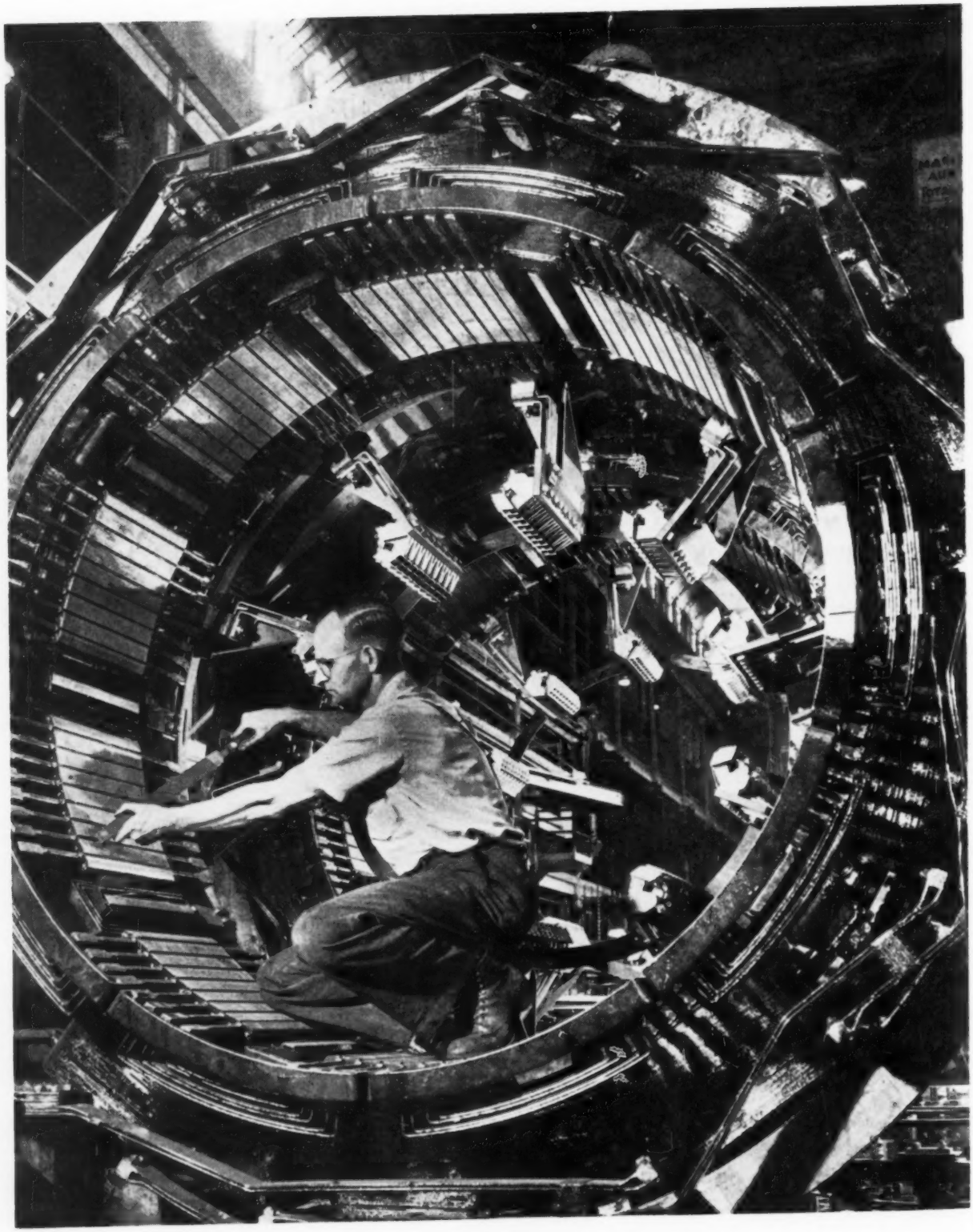

Steel Mill Power

(From machines such as this 2500-kw generator under construction at the East Pittsburgh Works of the Westinghouse Electric Corporation comes the steady flow of power that runs the nation's steel mills. A workman smoothes any "rough edges" inside the generator frame preparatory to final assembly. A second generator can be seen in the background.)

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MECHANICAL ENGINEERING

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GEORGE A. STETSON, *Editor*

Reader-Interest Survey

FOR a period of at least twelve months one out of every ten members of The American Society of Mechanical Engineers will have an opportunity to let the editors of this magazine know what they think about it. Beginning with the December, 1946, issue the editors have been sending out about 200 letters every month to members whose names were selected by ticking off every tenth name in the A.S.M.E. Membership List. With each letter there is included a stamped card on which the reader is asked to indicate his preference for certain regular departments of MECHANICAL ENGINEERING, to name specifically articles that have interested him, and to write such comments and criticisms as he may wish to get off his chest.

The response so far to MECHANICAL ENGINEERING's "reader-interest survey" has been gratifying in a number of respects. Tabulation of the replies from the first 200 letters showed a remarkably high percentage of returns. It has been encouraging to the editors that favorable comments have, so far, outweighed unfavorable ones by a large margin. Many useful comments and some constructive criticism will form the basis of doing a better job in the future.

The editors are not so naïve as to become smug as a result of favorable comments received. In fact, the reverse is true. They suspect that it is human nature, when such surveys are conducted, for persons who receive letters asking for comment to be overgenerous. They think it is more likely that those who wish to make favorable comments will respond than the reverse. After all, if a reader is not particularly interested in a magazine he is not likely to be sufficiently interested to respond to an invitation to comment on it. Everybody likes applause and even editors are human enough to be gratified by it. But a few brickbats may do more to stimulate better effort than bouquets will. The editors sincerely desire criticism and hope they are intelligent enough to profit by it.

It should be gratifying to readers who have taken the trouble to reply to the request for comments to know that each month's returns are analyzed and classified and a report covering them goes to the Publications Committee, which has expressed a lively interest in the survey.

Persons experienced in the interpretation of the type of reader-interest survey that MECHANICAL ENGINEERING is conducting have warned the Publications Committee and the editors that they must not expect to see any reliable pattern of helpful results within a year. For this reason there is no point in attempting at this early stage of the survey to report to readers the results so far obtained. When the time comes it is hoped that such a report can be made. At present, the editors wish to thank readers who have responded, to ask those who are yet to receive letters to reply to them as constructively as possible, and to encourage many of the other nine out of ten to volunteer comments. A magazine is published for the benefit of readers and in general it should be conducted to their satisfaction. The responsibility, however, rests on a few persons and the quality of their intelligence and judgment. Will you, as a reader, help us?

Civic Affairs

IT IS a common delusion of each of the various social and economic groups which make up a nation that it is the most important of all and should therefore assume control of the others or should be disproportionately represented in government. Competence in a limited area of human affairs is likely to engender belief that the group possesses equal competence in much broader areas. The delusion is sometimes fantastic and amusing, as in the case of the fly on the wheel; but when it comes to the horse between the shafts and the man holding the reins, there is room for argument. There are times when the driver wisely leaves the choice of speed and direction to the horse, relying on the natural intelligence of the horse to take himself, the carriage, and the driver safely to the stable.

Like other professional groups engineers frequently imagine that the dependence of society on certain of their skills entitles them to preferential positions in government. Being a good engineer may help a man to be a wise and competent public administrator but it is far from being a sine qua non. As good citizens, engineers should be encouraged, in so far as their abilities give them competence, to serve the public. No office is too high for them to aspire to.

The fact that the average engineer may have little chance of being chosen for high office should not blind him to opportunities of service to his fellow citizens in other capacities. Too frequently, public service is thought of only in terms of the individual and the holding of political office, and good citizenship is limited to doing one's duty at the polls. There are other ways of serving the public, which engineers have discovered, which require their particular skills and knowledge and

which are more effectively done by groups than by individuals. Just as there are times when a lost driver permits his horse to take him safely home, so also there are times when confused civil administrations may wish to permit engineering groups to lead them to their desired goals.

The article by S. M. Dean, "Detroit Engineers' Public Activities," gives examples of how a local engineering society has been able, through proper organization and wise leadership, to assist and advise governmental agencies on public questions of an engineering nature. Mr. Dean outlines clearly the numerous factors that are involved when public questions of an engineering nature are before a community and its administrative officers and commissions. When the Engineering Society of Detroit is asked, or on its own initiative, decides to interest itself in a public question of an engineering nature, it does so through its Civic Affairs Committee.

The position of the engineering society in such situations is strong because it can bring into play the experience and mature judgment of a wide variety of engineering groups acquainted with the local situation and because it has no "axe to grind." How the Civic Affairs Committee has gone into action in a number of specific cases and what the results of its work has been are described by Mr. Dean. It is apparent from Mr. Dean's story that, to revert to the analogy of the horse, it has sometimes been given its head and in others it has taken the bit in its teeth.

The importance of Mr. Dean's article lies in the fact that what Detroit engineers have done, engineers in other communities can do. It involves a lot of hard work, it requires sound judgment, both in engineering and in the handling of public affairs, and it demands courage and willingness to make certain sacrifices of time to the public welfare. Without the prestige and backing of organizations of fellow engineers, a small group would probably find it difficult to command the respect and support of the press and the public. A blunder on the part of the engineers, either in the advice they offered or in the manner in which they conducted their affairs, would be fatal to their future opportunities for service. Hence wise and competent leadership and professional thoroughness in doing the job are essential.

The consequences are too vital to be trusted to second-rate engineers or enthusiastic do-gooders. While a few engineers may do the work, credit for success and blame for failure or error will fall on all the engineers of the community and will reflect on the profession throughout the nation. Detroit engineers have been both farsighted and fortunate in choosing the right men to lead them in their civic affairs.

Another important feature of Mr. Dean's article is that it shows how engineers can meet their civic responsibilities, as individuals and as a group, without holding public office and without getting into politics. The engineer's approach, through civic-affairs committees, is not the political one, yet the consequences of his work may, through public opinion, have profound political effect. It is to be hoped that engineers in other communities will follow the example of the engineers of Detroit. Is there any better way of convincing the public of the engineer's competence, of enhancing the prestige of engineering as a profession, or working for unity within the profession?

The A.S.M.E. Boards

A BRIEF article in the February issue, "A.S.M.E. Committee Organization Changes," describes a new phase in A.S.M.E. administration procedure which was inaugurated by amendments to the By-Laws adopted during the 1946 Annual Meeting. The important feature of these changes is the organization of the activities of a majority of the Society's committees under six Boards to which it is the intention of the Council to delegate authority to act for it in certain specific matters. As each Board is composed of one representative of each of the standing committees it supervises, certain members at large, and a member of the Council, the Board is able to co-ordinate intelligently the work of the committee assigned to it and to maintain close contact with the Council. In addition to co-ordination the Boards will initiate projects and policies relating to the areas of the Society's activities that come within their scope. Delegation of certain powers to the Boards, with proper safeguards, will enable the Council, and particularly the Executive Committee, to devote attention to matters of policy and planning that are difficult to carry forward when concern for administrative details, now to be assumed by the Boards, demand a major portion of the Council's time.

The average member of the Society will hardly be conscious for some time of any effect on him as a result of this reorganization of committee activities. But if, as months go by, he is still unconscious of any improvement in Society administration, the Boards will have been created to no good purpose. For it is not the intention merely to introduce another step in the process of bringing a policy or procedure from the inception stage in a committee to the approval stage in the Council. The Boards should be able to act as quickly, if not more quickly, than the Council has been acting. With a smaller area of responsibility and with representatives of the committees on the firing line to provide the necessary information on which a decision may be taken, the Boards should also be able to act as wisely as the Council. Hence, present Society activities should be accelerated. The advantage to the Society will come not from the transfer of certain powers from the Council to the Boards, but in relieving the Council of so much administrative detail that it can spend its energies on planning and policies. Better services to members, to the engineering profession, and to the public should result from the change as the Council turns to these more important matters.

The Boards are largely untried instruments of Society operation. They hold great promise of speeding up and otherwise improving Society services to members.

DETROIT ENGINEERS' PUBLIC ACTIVITIES

By S. M. DEAN[1]

CHIEF ENGINEER OF THE SYSTEM, THE DETROIT EDISON COMPANY

THE Engineering Society of Detroit through its Civic Affairs Committee has attempted to take an active part in public questions of an engineering nature in the Detroit area. Basically, the functions of this committee are as follows:

1 To keep the membership of the society informed on public questions of particular interest to them.

2 To assist and advise governmental representatives and agencies on public questions of an engineering nature.

We have often heard it said that the keystone of representative government is an informed citizenry, which is undoubtedly true, but it is likewise important that the representatives elected by the citizenry shall themselves be well and wisely informed. By informing the Engineering Society membership on public questions, the Civic Affairs Committee hopes to distribute through the community a rather large number of well-informed persons who can answer questions and give information to others who may be interested. This amounts to an effort to keep the citizenry informed. On the other hand, assistance to the governmental agencies is an effort to inform them of good engineering practice and judgment concerning questions at hand.

A TYPICAL GOVERNMENT SETUP

In theory, a city government is like that of a corporate business in that it consists of three branches. One is the legislative branch made up of elected representatives of the people, which is the policy-making body. Its policies are carried out by the administrative branch headed by the chief executive. That branch is made up of those agencies responsible for day-to-day operation. Many of those operating agencies employ engineers and so-called "experts" to aid them in the solution of their problems. The third branch is composed of the co-ordinating or staff agencies, such as plan commissions, budget making or control groups, and the like. These agencies usually report to the chief executive—in most cases the mayor. Their function is to study situations and problems and to advise the administrative or legislative groups. They are, of course, no more effective than the backing which they receive from the chief executive.

The foregoing setup is theoretical and in practice the political factor enters the situation in the form of the degree of support the chief executive does or is permitted to give his operating and staff agencies.

Consider now the position of the elected representatives in the legislative branch, and for that matter of the chief executive and his administrative groups. I once heard the mayor of Detroit say, "I don't know everything; I'm just supposed to." That statement defines quite clearly their position. The problems brought before the legislative branch are almost as broad as the range of human endeavor, and the elected representatives are supposed to act wisely on each matter, taking full account of the widely divergent interests of citizen groups, business agencies, and the like. They cannot possibly be conversant with all matters, so they do just what any of us would do in a similar situation. They turn for advice to the several administrative agencies (which advice is often conflicting), or they turn to "friends" in whose judgment and integrity they have confidence. Finally, they act in the light of what information and advice they can get.

Now, what is the position of a general engineering society in such a situation? It should be possible for it to render very real assistance. Its strength lies in the fact that it is in a position to bring into play the experience and mature judgment of a wide variety of engineering groups acquainted with the local situation. The Engineering Society of Detroit has over twenty affiliated engineering groups, ranging from the highly technical groups on the one hand to such general groups as the Society for Management, on the other hand. These affiliated groups are bound to the society through its Affiliate Council on which each of them is represented. A second advantage is that such a general engineering society has no "axe to grind." While that is not entirely true, it is probably as true in the case of engineers as in any of the professional groups. Therefore such a society is in a position to offer not only experienced technical advice to governmental departments and agencies, but also the benefit of mature broad-gage judgment on many questions of wide scope such as those involved in city and regional planning.

ADVICE ON GOVERNMENTAL MATTERS NOT ALWAYS WELCOME

While all of this sounds quite logical and reasonably simple of attainment, our society has found it to be a rather complicated matter. The attitude of the governmental agencies and representatives toward such advice and judgment is not always one of co-operation. As a usual thing, a given administrative agency will welcome technical advice given to its group, and in that field the course is relatively easy. However, where information and advice are offered on such broad-gage problems as arise in city and regional planning, the reaction will turn very largely on the degree to which that advice is in accord with the particular plans and ambitions of the several administrative agencies involved, that is, the reception may simultaneously range all the way from enthusiastic support to bitter and partisan opposition, and one must be prepared for that sort of reception.

If such general advice is brought into play through some co-ordinating agency such as a plan commission, and that agency has the support of the legislative branch and the chief executive officer, it will probably be well received and will be of value. However, if the advice is contrary to the wishes of such a planning agency (reflecting as it must the desires of the several administrative departments), or if the planning agency does not have the support of the legislative and administrative branches, then the advice may not be well received.

[1] Chairman, Civic Affairs Committee, The Engineering Society of Detroit, Inc.

Contributed by the Civic Affairs Committee of The Engineering Society of Detroit, Inc., and presented at the Annual Meeting, New York, N. Y., December 2–6, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

I think this latter situation can be summed up in the reply made by the administrative head of a responsible governmental agency in the Detroit area who, after having had the benefit of the work and advice of a prominent engineering concern, said, "This is an excellent report, but it tells us to do things we don't want to do." In other words, it was sound engineering but it conflicted with the political ambitions of the particular group he represented.

If the conflicting interests of such groups can be reconciled by a strong administrative officer as is the common practice in private business organizations, good results can be had and a measure of co-operation achieved. On the other hand, if the chief administrative officer of the government is not inclined in that direction or is inclined to give undue weight to political considerations, the result may not be one of co-operation, and the engineering group which has been advising in such a situation may find its advice pigeonholed.

The advising group then faces the question of whether the matter is important enough to justify taking it over the heads of the administrative officers of the government into the legislative branch, or, failing there, to take it to the citizens, perhaps through the press.

This situation is outlined for just one purpose, namely, to make clear that engineering groups which seriously propose to take an effective position in public affairs will sooner or later be forced to stand on their own feet before the legislative branch or possibly before the public itself. In so doing they will find themselves in the politician's own stamping ground and will inevitably be accused of partisanship with the attendant risk of losing their "amateur standing" in the mind of the public unless their position is very strong and clearly defined.

If, on the other hand, in the long pull, they can build up a reputation for sound judgment in public matters, they may win public and government confidence and thereby become a potent force in public affairs. In passing I might add that in these situations, luncheon decisions and glib talk about the engineer taking his place in public affairs is not enough. Someone has to burn the midnight oil and know whereof he speaks.

LEARNING THE HARD WAY

I would like to have the reader think that the Civic Affairs Committee had thought the foregoing situation out to a conclusion, but that is not the case. We learned the hard way. In fact, we started out some years ago with the rather naive impression that all that was necessary was to bring forth a carefully prepared and mature engineering plan and that it would meet with universal acceptance. We have learned differently. In looking back over the several years of activity, I can recall a number of instances in which I might have done a better job of steering our activities. The only comfort one gets from hindsight is that of avoiding those same pitfalls in the future. It is with the thought that our experience might be of some assistance to others who are moving along this same road that the following incidents from the activities of our society are presented.

THE CASE OF THE DEFECTIVE INCINERATORS

A few years ago the City of Detroit decided to build several large garbage incinerators in the semi-industrial areas. These were rather carelessly operated, and one of them was shut down by an injunction arising from a near-by residential area. Competent consulting engineers advised that with certain changes the plant could be successfully operated, and the court allowed the city a three-months' trial period to demonstrate its ability to operate in a manner satisfactory to the surrounding neighborhood.

The city approached the Engineering Society asking for the appointment of a committee of engineers competent to act as observers during the trial period. The society selected a civil engineer conversant with incinerators, a combustion engineer, and a chemical engineer. This committee carefully followed operations in the field, made suggestions for improvement, and finally filed affidavits with the court to the effect that with relatively few additional changes the incinerator could be satisfactorily operated, and on that basis recommended the vacation of the injunction.

The case was settled by the judge "in chambers," the injunction vacated, and the plant has now been operating some two years without difficulty. The importance of this suit was twofold: (1) Had the injunction been made permanent, it would almost certainly have resulted in the closing of all four of the city's incinerators, and the creation of a very critical problem involving not only serious financial loss to the city, but also how to dispose of garbage in the meantime. (2) The closing of incinerators in one large city would almost certainly have raised similar questions in other cities. In this instance, The Engineering Society of Detroit performed a very valuable service to the City of Detroit and perhaps to other cities.

CONTROVERSY OVER PARKING METERS

Some years past, the city was interested in the purchase of parking meters to be installed on the downtown streets of Detroit within a certain trial area. Some of the city officials felt concern over their ability to choose wisely, from the different types of meters offered, the ones that could best be used for that purpose. Political pressure was a large factor in the situation. Accordingly, the city traffic engineer approached our society asking if it would undertake to advise the city purchasing department and himself as to which of the meters should be tried out.

The society indicated willingness to be helpful, and on one bright morning there was delivered to my office ten different types of parking meters for purposes of review and testing. With the aid of some of my business associates, a series of tests were made on these parking meters intended to demonstrate the ability of the meters to operate under field conditions, namely, rain, low temperature, dust, impact, and the like. Careful analysis indicated that none of the meters was entirely suitable, but that with some modifications three of them might well be applied.

A confidential report to that effect was made to the city traffic engineer. This report was turned over to the city purchasing department which, instead of quietly purchasing the three types of meters, announced more or less formally that the other seven were thrown out of consideration because the engineers (ESD) said those meters did not qualify. A great deal of argument took place. The controversy went on for some time, during which several modified meters were brought in and also a new "dark horse" meter which had been invented by one of the men who had been doing the testing. It was then proposed that the city take over the rights to the dark horse meter and make its own meters. As a result of this discussion, a new set of tests was made, including the modified commercial meters in question and the new dark horse meter, and another report was submitted.

Finally, the makers of the unsuccessful meters in the latter test demanded a public hearing before the city council, at which time it became necessary for the "engineers" to go before that body and justify their report. They were able to do that successfully and received the thanks of the city council for their assistance.

The engineers rendered a very useful service and came out of the discussion with "clean faces." This will illustrate what

I mean by saying that any engineering group, dealing with public questions, must be prepared to defend its position. This necessity is further borne out by a remark of one of the members of the Detroit traffic-control committee made during this controversy. "Unless you engineers are prepared to stand up and defend your position, your advice is of no value to any city agency." Manifestly, he was right.

Unfortunately, shortly thereafter the city council decided not to buy the meters anyway, which ended the matter.

REGIONAL AVIATION PLAN

Let me relate another example in which the society has undertaken to "do a job" on a regional basis.

A year or so ago, our society became convinced of the necessity for a regional aviation plan to be co-ordinated with the aviation plans of the state and of the Federal Civil Aeronautics Administration, and we took a leading part in enlisting state funds and forming the Detroit Metropolitan Aviation Planning Authority to get such a plan worked out. We further sponsored the formation of a permanent regional aviation authority with power to lay out a regional plan, to submit a financial plan to several of the legislative bodies in the area, and to co-ordinate the carrying out of that plan in co-operation with the state and federal agencies.

The necessary enabling legislation has been passed by the State of Michigan under which such a regional aviation authority may be set up. Again, we encountered conflicting political and private interests and there was a good deal of hue and cry. However, I am pleased to report that all five of the governmental agencies involved agreed to go along in the formation of such a regional aviation authority which was to be set up early in 1947, with funds available to pay for its first year of operation.

Metropolitan Detroit is fortunate in having the Willow Run airport available at not too great a distance which will "hold the fort" until the newly constituted regional authority can work out a proper plan and build such additional airports as experienced judgment indicates to be necessary. There is no need to rush into ill-conceived action on the part of any of the governmental groups involved in the region. In this situation, we have been accused of being obstructionists, but we console ourselves with the belief that, had it not been for the planning agency sponsored by the society's Civic Affairs Committee, the City of Detroit would now be engaged in building an airport at a cost of 15 or 20 million dollars without proper regard for the needs of the region or of other types of aviation.

TRANSIT SITUATION HAMPERS CITY PLANNING

The city's aviation problem is not the only field in which we have endeavored to be of help.

Shortly after the Civic Affairs Committee became organized along its present lines, it set up a working group to co-operate with the city and regional planning agencies. That group started out by attending the meetings of the city plan commission and was several times the guest of the plan commission staff with respect to particular aspects of their work. The Civic Affairs Committee also sponsored a meeting of The Engineering Society of Detroit at which the city plan commission staff outlined the preparation of the master plan for the city. Later, the society gave a dinner for the plan commission at which several society's officers and directors as well as the Civic Affairs Committee set forth their opinions as to several aspects of city and regional plans.

It early became apparent to the committee's planning advisory group that too little attention was being given to a properly co-ordinated local transportation and transit system. Accordingly, the Civic Affairs Committee addressed a letter to the city plan commission calling attention to this and urging that it secure the advice of experienced and transit engineers to co-operate with the plan commission in working out that aspect of the city master plan. Our committee also urged that the plan commission assume the rule of the co-ordinating agency with the advice and assistance of the department of street railways and other city departments involved. As a result of this letter and of the requests of other groups in the city, the plan commission went to the mayor asking to be authorized to take such steps. Unfortunately, His Honor did not see it that way and accused the plan commission of attempting to seize political power and declared that transportation was the function of the department of street railways which should be in the best position to determine the city's needs. The result was that nothing happened for a year.

Finally, under pressure from a number of citizens' groups, the mayor appointed a transportation board, consisting of representatives of several city departments (including the department of street railways and the traffic-engineering department), with instructions to retain consulting engineers and to prepare a comprehensive transportation plan for the Detroit area. Some months later that plan was brought in and our society was informally asked to review it and to submit an opinion. The society did so in a letter to the mayor, pointing out in general that the plan was comprehensive and with some modifications should be acceptable, and urging that immediate steps be taken to put it into action. In particular, the society pointed out the inadequacy of the rapid transit part of the plan and urged that provisions for future rapid-transit lines be incorporated in all of the depressed expressways which the plan proposed for the handling of public and private automobiles. However, the transportation board seemed unable to reach agreement on an acceptable plan.

In the meantime the department of street railways brought forth a "modernization program" which not only made no provision for adequate future rapid-transit systems but committed the city to an "all-bus" transit system employing only a few streetcars and no rail rapid transit of any kind. As a result, the plans prepared for the transportation board were pigeonholed and the mayor accepted the modernization plan as being one which he said was adequate and would cost very much less than any that had been proposed.

The Civic Affairs Committee then made a careful study of this modernization program and became convinced that provisions of that plan would close the door to adequate rapid transit in the future, except at very great additional cost, and again urged the need for rapid-transit rail facilities in the expressways and an adequate system of underground subway tubes in the downtown area. While the city council had not adopted the modernization program proposed, it did authorize condemnation of certain land for the building of bus terminals which in some measure committed it to the plan. Shortly thereafter there was proposed a financial plan which seemed to the Civic Affairs Committee to amount to a ratification of the modernization program without its ever having had adequate discussion or consideration, either by the city council, the transportation board, or the city plan commission.

The board of directors of The Engineering Society decided that the situation was serious enough to warrant a formal protest. However, they faced the question of where to take their protest. The mayor and the department of street railways were irrevocably committed to the modernization program. The city plan commission had proved ineffective, and the transportation board was moribund. It was finally decided to stand on our own feet and ask for a hearing before the city council. Accordingly, the president of the society appeared before that body, pointing out the inadequacy of the modernization pro-

gram under way, and urging that the whole situation be reqiewed and the several aspects of the plan properly co-ordinated before major commitments were made. He stated the Civic Affairs Committee was preparing a statement on the situation which would be forthcoming shortly.

As a result of this action, the city council appointed a transportation study committee made up of representatives of several city departments and headed by the planning director of the city plan commission, to study the several plans and to recommend a proper one for the City of Detroit. The council also asked that the statement prepared by the Civic Affairs Committee be placed in the hands of that study committee and in the hands of the other governmental departments. That was done, and the engineers' statement was widely publicized in the newspapers. This statement was the subject of severe criticism by the mayor and the department of street railways, but it did receive the support of some of the newspapers and some of the political groups involved throughout the city.

The new transportation study committee then asked the Civic Affairs Committee to appear at a public hearing before it and to state its case, which it did. The committee likewise asked the department of street railways to submit their modernization program which had never been set forth in any detail. After some months of delay that program was submitted. The Civic Affairs Committee is again organizing itself to study that plan and, if necessary, to go before the new transportation study committee and, if need be, the city council to urge again the preparation of a properly co-ordinated transportation plan

The board of directors of the society and its Civic Affairs Committee feel so strongly the importance of an adequate transportation plan for the future development for the City of Detroit that they have "on their own" stepped out into the political arena to insist that the governmental agencies do a good job for the City of Detroit in this respect. The Civic Affairs Committee has the support of a very large number of experienced transportation design and planning engineers and agencies. The society has its feet in the political "mud" and is learning rapidly. We believe very strongly that the future well-being of the city calls for a much more adequate transportation system and propose to make every effort to get it.

WIDELY DIVERGENT PROBLEMS RECEIVE COMMITTEE'S ATTENTION

In addition to these rather broad problems there are a number of others in which the Civic Affairs Committee is taking an active interest. Among these are smoke abatement, river-front development, an off-street parking plan, the sanitation problem, and certain specific projects now faced by the city engineer's office.

Smoke control and abatement in Detroit has lagged woefully. Our committee has taken an active interest in the problem because we feel it to be of basic importance. It is of little use to plan for the rehabilitation of blighted areas unless living conditions in those areas can be made such that people will be willing to reside there for years. Short-lived developments would not pay out. Dirt conditions in such areas are bad and smoke and ash are responsible for much of the difficulty. This problem will have to be solved, as will also the noise problem before such areas can be developed on a permanent basis.

Detroit's smoke ordinance was drawn thirty years ago. The corporation counsel has been instructed to write a new one. He asks the department of buildings and safety engineering, which agency is responsible for smoke abatement, what should be in such an ordinance, and receives only vague generalities in reply because that department has no plan.

The Civic Affairs Committee is attempting to act in the role of catalyst and to help these agencies define their problem and arrive at a practicable remedy. It has brought in from St. Louis, Prof. Raymond Tucker, the individual most responsible for the excellent results produced there, who has told the interested city departments how the problem was handled in St. Louis. If a proper plan and ordinance can be worked out, the committee has in mind helping the department of buildings and safety engineering to secure executive approval of its program and the necessary appropriations to carry it out.

In a somewhat similar manner our committee is attempting to help in modernizing the procedures for the licensing of steam-boiler operators which are also very antiquated and inadequate.

CONCLUSIONS

Several times we have been asked how we know that the society membership would actually support our position in each of the several cases After a great deal of thought, it was felt to be impractical to poll the 12,000 members and affiliates of the society on even the most important questions. In the first place it would be very difficult, if not impossible, to place before them information complete enough to permit of their making an intelligent decision. Furthermore, only a few of them are in position to form independent judgments on complicated questions such as those involved in broad regional problems. In addition, the cost of doing so is rather formidable. Since the society's directors are elected by the membership, it was felt wise to proceed after the manner of a legislative body, to keep the membership advised through the society's monthly publication *The Foundation*, and to be guided by such membership reactions as might come to us. So far, we have had almost no adverse comment. At long last, the membership's remedy is that of any group of voters, namely, to elect other directors.

The cases which I have reviewed in some detail will serve to give some idea of where we now stand. The Civic Affairs Committee and the board of directors of the society have, step by step, moved into a position in which it has been necessary for them to take an open public stand in matters which in their judgment are of sufficiently vital public interest to make such steps advisable. We are irrevocably in the limelight. We have had not a few political brickbats thrown at us, but we firmly believe that we are moving in the public interest. We hope that in the long pull we shall not lose our "amateur standing" as a qualified unprejudiced citizen group. Already we are beginning to be invited by governmental agencies to give advice in advance of publicly announced decisions—a hopeful sign.

THE DRIVING force of the educational program of the professiona schools of the future—whether they be schools of engineering or of creative art—is likely to be scientific humanism.

Scientific humanism means a marriage of science and the accumulated arts of the past; it cannot tolerate separate disciplines moving along parallel lines in accepted grooves of departmentalization. Scientific humanism is a fusion, a synthesis of science art, and philosophy, a union out of which is born the intellectual life of the future. The product of this educational philosophy will be not merely an engineer or a creative artist but a well-rounded man who has intellectual associations with fields other than his own. He will be liberal, feared both by the reactionary and the radical, because he will believe in and protect the essential dignity of the individual. He will observe those three values which are basic to democracy: freedom of speech, freedom of action, freedom for experimentation. He will have faith in the ability of people to work out their own solutions to problems. He will aim to preserve our democratic society because his education has made him not only an artist or an engineer, but a good citizen. (From Report of Director of The Cooper Union, June 30, 1946, pages 2–4.)

Uses of LIGNIN *in* AGRICULTURE

By STUART DUNN[1] AND JOSEPH SEIBERLICH[2]

UNIVERSITY OF NEW HAMPSHIRE, DURHAM N. H.

A LARGE part of cellulose and wood waste decays on farmland and in forests. This decay is caused, not so much by soil organisms, as it is by wood-rot organisms which the wood carries with it. Later bacteria and other microorganisms of the soil continue this destructive work. These organisms are well represented in practically all soils since soil is no more considered as being just decomposed rock, but decomposed rock modified by ages of contact with living and dead organisms. The total number of microorganisms in soil may vary enormously from one million to several billions per gram depending chiefly upon (*a*) available organic substance; (*b*) favorable oxygen relations; (*c*) available water; (*d*) soil reaction (pH); (*e*) favorable temperatures.

The end product of the wood-decaying process or of decay of any plant or animal remains is humus. Humus is difficult to define but it is primarily a complex aggregate of brown to dark-colored amorphous substances which profoundly modifies the soil character. The microorganisms carry out this conversion as a result of their growth and multiplication, thus increasing the cell substance enormously. Thus they are responsible for the deposit of considerable amounts of nitrogen, phosphate, and other inorganic compounds in the organic constituents of humus. It is important to note in this connection that wood products before decay has advanced very far are bad for the growth of higher plants. Experiments have shown that fresh sawdust, either mixed with soil or applied as a mulch, seriously inhibits plant growth, while growth with rotted sawdust was excellent. This is because the organisms during early decay use large amounts of nitrogen which would otherwise nourish the crop.

Recognizing that the process of formation of humus is a very complex one, most of the evidence summarized by Waksman[3] indicates that a large part of humus is derived from lignins or is lignin in a modified form. This, then, forms most of the basis for the desirability of experiments with lignin of industrial origin to determine something about its effects on soil and plants.

LIGNIN AN ABUNDANT CONSTITUENT OF PLANT LIFE

Next to cellulose, lignin is the most abundant constituent of the plant-cell walls. In comparison with the large amount of data available on cellulose, very little is known about the chemical and physical structure of this compound and products formed by its decomposition. This is due largely to the difficulty of isolating lignin from plant over material in its chemically unchanged form. Therefore a distinction should be made between two types of lignin.

The first type of lignin, as it occurs in the living plant or tree, is generally called "protolignin" or unaltered lignin. Whatever the nature of these unaltered lignins in the living plant may be, it is now becoming clearly recognized that they represent chemical compounds extremely sensitive to the action of chemical reagents such as alkalies or acids by which they are readily converted into dark amorphous polymer-condensation products.

The second and much more familiar type of lignins are those which are derived from plants and trees by chemical or biological action from the combined material known as lignocellulose. Lignin and cellulose are the chief constituents of lignocellulose. Its chemical bondage must be strong since it requires strong chemical action to free the lignin from its combinations. The isolation process of lignin from its components is accompanied by condensation to large complexes. While this may not be an obstacle for the investigation of its chemical structure, it might make quite a difference as concerns the biological effect of the material.

The chemical nature of lignin is not yet clear. Ultraviolet spectra of dissolved lignin seem to indicate the presence of a benzenoid structure. All isolated lignins have proved to be optically inactive.

COMPOSITION OF ISOLATED LIGNINS

The composition of isolated lignins varies with the species of trees. Isolated conifer lignin contains largely catechol derivatives, while deciduous woods furnish lignin consisting of catechol and pyrogallol derivatives (syringyl-rests). If isolated lignin (wood hydrolysis lignin, peat, etc.) is extracted with water, the pH of these solutions varies between 4.2 and 3.5. The pH of sap in trees varies between 6 and 5. These results were obtained from many sap determinations, and it seems difficult to accept the idea that such variations of the pH of the sap and lignin could be present in the living tree. It seems more reasonable to believe that the pH of a sap gives some indication as to the pH of the surrounding cell tissues (lignocellulose). However, if sap is exposed to air for some period of time, its pH decreases and approaches that of the isolated lignins. This may explain the lower pH of isolated lignin due to oxidation which takes place during exposure of lignin to air, especially in the presence of moisture. Color changes also seem to point in the same direction. While the darkening of color of freshly cut wood exposed to air is often explained to be due to the drying up of sap in the wood, it has been found that even after careful removal of the sap, the color difference between freshly cut wood and wood exposed to air remains.

LIGNIN POSSESSES COLLOIDAL PROPERTIES

It is generally accepted today that plant lignin during its isolation process condenses to larger units (polymerization). Therefore isolated lignin is not a simple organic structure any more but it enters the field of high molecular substances which are generally considered to be of colloidal type. This colloidal character of lignin has been demonstrated. Isolated lignin possesses adsorption properties comparable to those of other colloids. It has been found by experiments that the presence of a slight amount of moisture in isolated lignin is essential in order to show adsorptive properties. Bone-dry lignin shows hardly any adsorption, a fact which agrees with the behavior of many thoroughly dried colloids. Experiments have shown that acids are less adsorbed than alkalies but in every case the adsorbed matter was held tightly, which might indicate some form of chemical linkage. The acid character of isolated lignin was also experimentally established. Acid dyes possess a nega-

[1] Assistant Professor of Botany and Plant Physiologist.
[2] Research Assistant Professor, Industrial Engineering.
[3] Refer to Bibliography at the end of the paper.

Contributed by the Wood Industries Division and presented at the Fall Meeting, Boston, Mass., Sept. 30–Oct. 3, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

tive charge, while basic dyestuffs carry a positive charge. By this means the basic or acid character of the sorbens may be determined. In the case of isolated lignin, it was found to show great affinity to basic dyes. From this it may be concluded that isolated lignin gives a negative charge and thus exhibits acid character.

These findings of colloidal properties of isolated lignin seem to be of special interest in the case where these lignins are employed as carriers or adsorbents for substances to be applied as a fertilizer or carrier as well as for the behavior of isolated lignin in soil.

Pertinent to this property it may be mentioned that lignin in the finely divided state will adhere in considerable amounts to the fine rootlets of seedlings. Seedlings of corn, sunflower, and pea have been grown in water culture, to which has been added small amounts of colloidal lignin. The roots were noticeably colored brown in comparison to more whitish ones of the controls. This suggests that lignin when added to the soil may have an important role like other constituents of humus in forming an intimate film about the rock particles and root hairs which aids in transfer of water and soil nutrients to the root cells.

CHEMICAL CHARACTERISTICS IN PROCESS OF HUMUS FORMATION

The structure of isolated lignin as well as its formation during the life of the plant is not known definitely. There are, however, natural plant products, the structures of which are known and which seem to be in close relationship to lignin, as, for example, coniferyl alcohol, isoengenol, etc.

Lignin exposed to air is subjected to an oxidation process besides the accompanying biological decomposition process. It has been demonstrated that, under mild chemical oxidation, simple degradation products are formed such as formic acid, acetic acid, oxalic acid, malonic acid, succinic acid, and others. Small amounts of aromatic acids were obtained only by applying drastic oxidation methods. All acids formed during oxidation of the lignin may exist free or combined when lignin is incorporated into the soil.

Lignin of fresh plant tissues may be partly decomposed by the action of higher fungi but once the lignin becomes isolated it becomes resistant to attack even by these organisms. The chemical nature of lignin in the plant varies with the age of the plant as could be demonstrated by its increase of methoxy groups. Apparently lignin of younger plants seems to be more readily attacked by microorganisms than in older plants. Therefore, due to its high resistance to attack by microorganisms, the amount of lignin in soil increases while the amount of cellulose, pectin, etc., decreases and finally disappears. This is the process of humus formation. With the gradual transformation to humus in soil, lignin increases in adsorption and in solubility in alkali. Its color becomes darker and it combines with proteins. The alkali-soluble fraction of lignin, the so-called humic acids, differ from the original lignin by a lower methoxy content, darker color, and the presence of nitrogen.

FERTILIZER EXPERIMENTS

Fertilizing experiments, using lignin from the wood-saccarification process received by the courtesy of the Forest Products Laboratory, Madison, Wis., and carried out in cooperation with the Agricultural Experiment Station already have indicated some beneficial influence of lignin in soil. Some results already have been reported at Orono, Maine. Further studies on the varieties of lignin, and comparison with sulphite-waste liquor, lignin, and peat are now under way. This project opens new aspects relating to lumber operations, especially on the recovery of wood waste and making use of it for improving soil structure.

These experiments have been along two lines: namely, (*a*) soil cultures with lignin added to the soil in which crops were grown; (*b*) water and sand cultures to which lignin was added in very small amounts. All were carried out in the greenhouse.

For the soil cultures, potatoes, tomatoes, onions, radishes, peas, lettuce, and beans were grown, all except the first two, only once and with few plants. Potatoes were grown in large galvanized pails with the lignin added in layers between layers of soil. The interior of the pails was coated with beeswax to prevent corrosion. Fertilizer was added to these as well as to cultures without lignin for control, and to cultures with peat for comparison. About 800 ml of either lignin or peat were added per pail. Other crops were grown in smaller containers.

In general, potatoes showed some benefit from lignin treatments over controls and somewhat less benefit compared to peat treatments. Onions in the one attempt made with them showed marked benefit from lignin applications. Tomato yield was not increased over controls by lignin but was helped by treatments with rotten wood. Here soil-nutrient tests indicated a more complete exhaustion of nitrogen in all organically treated soils than in controls. This indicates that more attention should be paid in future experiments to increasing the applications of nitrogen as well as possibly other nutrient elements during growth. The other crops mentioned were not helped by the lignin treatments, although it should be mentioned again that only one attempt was made with them and that the amount of lignin or other organic material best for growth may not have been added. In work of this kind the problem of finding the correct dosage is quite critical.

The tests with sand and water cultures involved growing the plants in these media by conventional methods known and used by plant physiologists for a long time. The plants were grown mostly in 1-gal-size glazed crocks with their roots immersed in water or sand. To some were added mineral nutrients only and to some small amounts of sifted lignin or other colloidal material. This was an effort to find out more about the specific effects of these materials on plants, because the many variables involved can be more closely controlled. However, it is a rather laborious method and the cultures require a large amount of attention. Again, these experiments were largely exploratory, but as far as they have been carried on the results show considerably better growth in sand cultures treated with lignin than untreated controls, but no differences in water cultures. A surface effect may be involved here, namely, that of more intimate contact between the roots and sand particles as already discussed.

Thus far no attempts have been made at the New Hampshire Station to apply any lignin or allied materials in field trials, but results reported from Seabrook Farms, Bridgeton, N. J., indicate considerably increased yields of lima beans from applications of ligninsulphonate to field plots. Other experiments in Oregon, using the waste sulphite liquor in irrigation water, were inconclusive in so far as benefit to yields was concerned, but did indicate that it is safe to apply up to 60 tons per acre per year under their conditions.

REASONS FOR BENEFICIAL EFFECT OF LIGNIN

Some general indication has already been given of the underlying reasons why lignin additions to soil may be beneficial. Thom and others have stated that it is largely by improvement of soil texture. This implies a large number of other things such as better water penetration, water-holding capacity, fertilizer holding, etc. It does not rule out the possibility of stimulus to higher plants from very minute quantities of organic substances, perhaps arising as a result of action of microorganisms. The possibility of increase in carbon-dioxide fer-

(*Continued on page 212*)

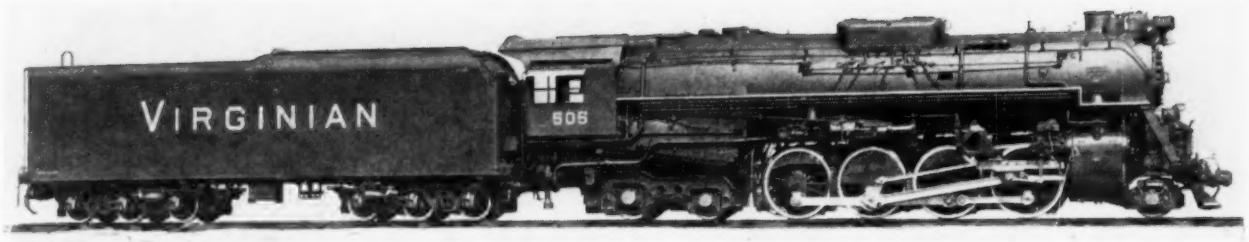

FIG. 1 2-8-4 FOR THE VIRGINIAN

PROGRESS *in* RAILWAY MECHANICAL ENGINEERING[1]

1945-1946

ALTHOUGH the railroads emerged from the period of World War II without the reconversion problems with which much of industry has been beset, they did find themselves entangled with the same difficulties predominant in all business, namely, those of material shortages, wage, price, and labor difficulties, and an unprecedented peacetime demand for goods and services. With the failure to secure adequate rate increases, the railroad financial situation has not reflected the level of the nation's prosperity in general. In so far as railway mechanical engineering is concerned, the railroads' financial status has served to bring about an increased consciousness on the part of operating officials toward locomotive economics.

Despite the fact that better than 90 per cent of the country's railroad freight is being handled by the steam locomotive, there is a definite trend to the Diesel-electric locomotive in not only freight but passenger service at a rate limited principally by the manufacturers' ability to meet the carriers' ordering requirements.

Indicative of the trend is the fact that on September 1, 1946, locomotives on order totaled 556 of which 69 were steam, 6 electric, and 481 Diesel electric. This compares to a total of 512 locomotives on the same date in 1945, which consisted of 107 steam and 405 Diesel electric.

Nevertheless, technological advancement in steam-locomotive development continues to such an extent that its continued important place in the railroad motive-power field is well assured. Research is an indispensable part of railway technical progress and, no longer being under wartime restrictions, it has revealed a multitude of projects now well under way. Whether in the design or constructional stage, modern steam-locomotive development is indicative not only of the industry's determination to retain its pre-eminence in the transport field, but points toward more intensive competition between the various types of motive power. The steam-locomotive designers and builders are achieving noteworthy success in narrowing the margin of the Diesel electric's advantage in continuous availability. Monthly mileages on steam locomotives are reaching new peaks and some of the roads are improving steam-locomotive operations to the extent of running them close to 1000 miles without change.

In addition to that secured with the conventional steam locomotive and with the Diesel electric, progress in the development of the turbine-powered locomotive has been sufficient to bring a realization that railroad motive power may be subjected in the near future to another radical change in form.

Shortages of materials and equipment, and other production difficulties have retarded deliveries of new passenger and freight cars. During the first 6 months of 1946, freight-car deliveries were fewer than in the corresponding months of 1945, although orders placed were more numerous. The effects of wartime deterioration and postponed retirements are reflected in the fact that nearly twice as many freight cars have been retired during this period than in the corresponding 1945 period. At the same time, the demand for freight cars remained as high as in 1945, even though revenue ton-miles of freight carried declined by approximately 25 per cent.

Some of the foreign locomotives included in this report were developed and constructed prior to the period which the report is intended to cover. Some of the information now included was not available for previous reports, particularly from continental Europe, because of difficulties in communications imposed by wartime censorships and travel handicaps. Justification for its inclusion at this time is the fact that it has not been published heretofore in this series of survey reports.

DOMESTIC STEAM LOCOMOTIVES

Item 1 of Table 1, and Fig. 1 describe a 2-8-4 originally developed by Lima for the C. & O. and subsequently adopted with but minor changes by the Virginian for heavy freight service on the eastern end of the Virginian's lines. The use of an existing design in this case indicates a trend toward a much needed standardization of steam-locomotive designs—a trend encouraged during the war years by governmental insistence on the use of existing designs for new locomotives.

The twenty-five 4-8-4's, the "Niagara" type, mentioned in this committee's last previous report, were completed by the

[1] Report of Committee RR-6, Survey, chairman T. F. Perkinson; members, F. Benger, E. R. Battley, E. D. Campbell, R. P. Johnson, H. C. Wilcox.

Contributed by the Railroad Division and presented at the Annual Meeting, New York, N. Y., Dec. 2–6, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

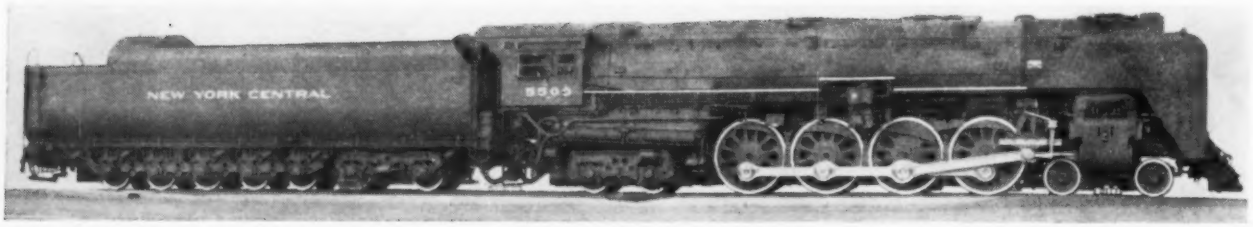

FIG. 2 NEW YORK CENTRAL "NIAGARA," EQUIPPED WITH POPPET VALVE GEAR

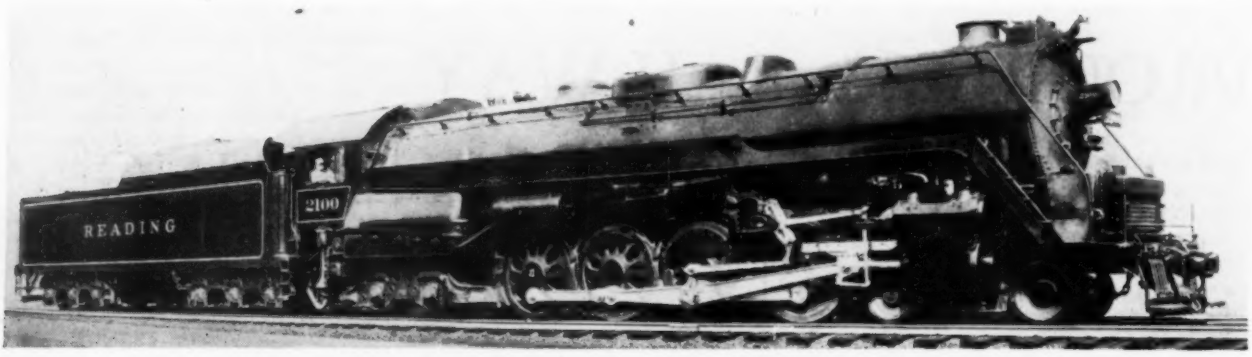

FIG. 3 READING T-1 4-8-4 BUILT IN COMPANY SHOPS

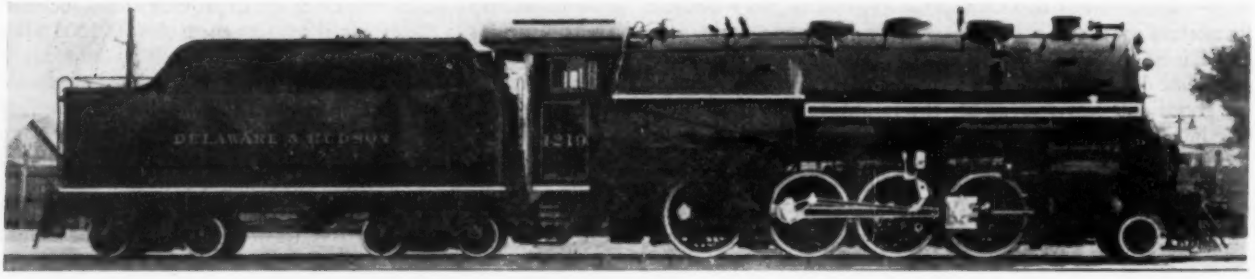

FIG. 4 D. & H. LOCOMOTIVE USING AN ALL-WELDED BOILER

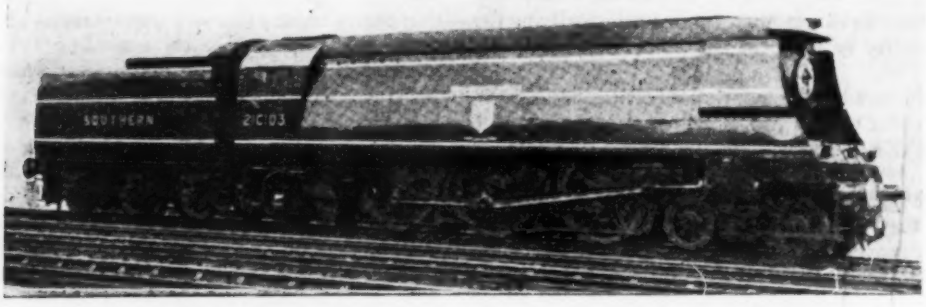

FIG. 5 THREE-CYLINDER 4-6-2 FOR THE SOUTHERN RAILWAY OF ENGLAND

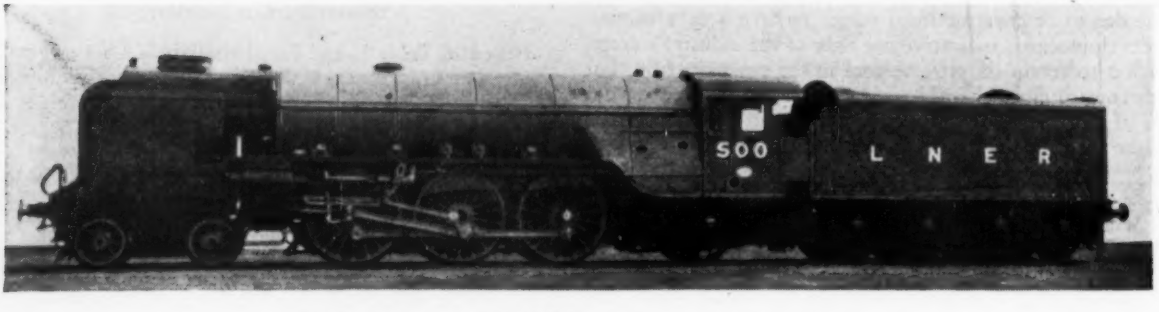

FIG. 6 THREE-CYLINDER 4-6-2 FOR THE L.N.E.R. OF ENGLAND

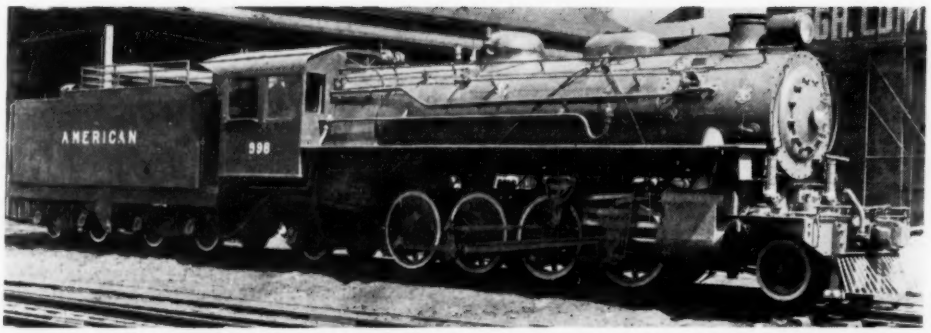

FIG. 7 WOOD-BURNING 2-8-2 FOR THE BELGIAN CONGO

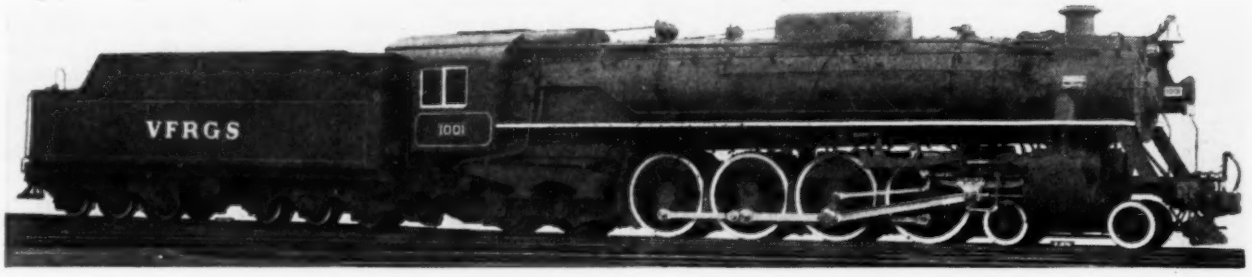

FIG. 8 METER-GAGE 4-8-4 FOR THE BRAZILIAN RAILWAYS

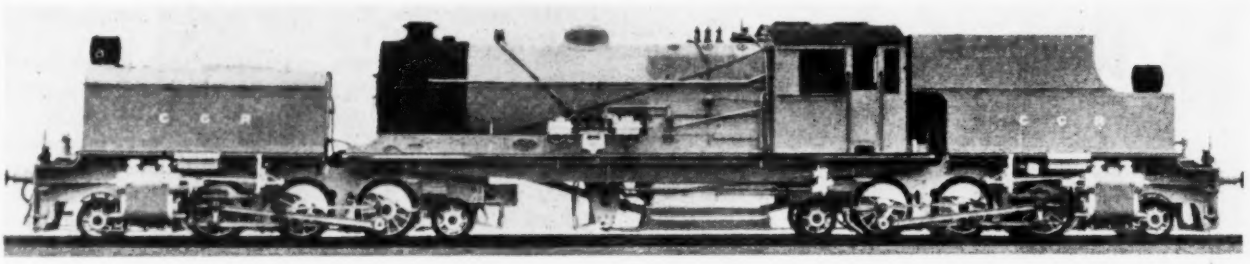

FIG. 9 66-IN-GAGE BEYER-GARRATT FOR CEYLON

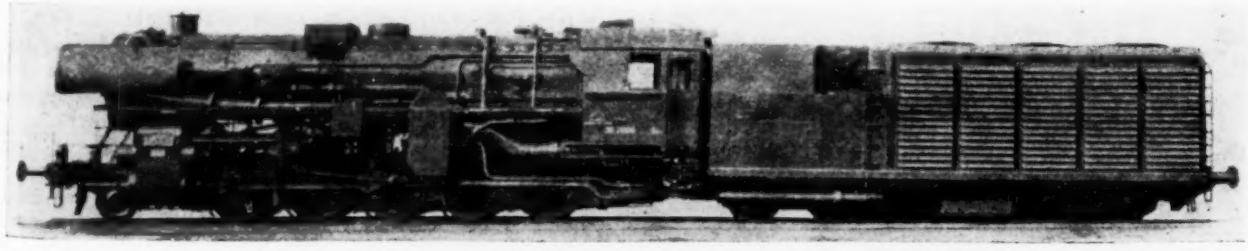

FIG. 10 GERMAN CONDENSING LOCOMOTIVE BUILT DURING WORLD WAR II

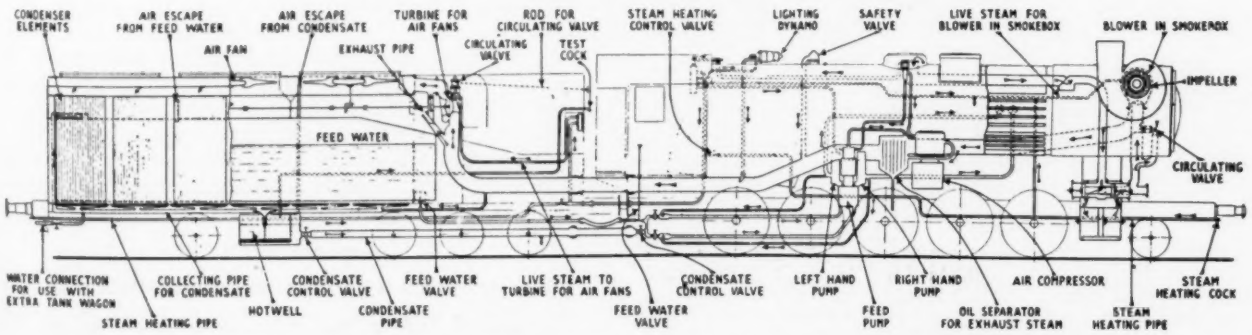

FIG. 11 GENERAL ARRANGEMENT OF CONDENSING SYSTEM ON GERMAN LOCOMOTIVE

TABLE 1 STEAM LOCOMOTIVES FOR SERVICE IN THE UNITED STATES

Item	Builder	Owner	Wheel arrangement	Service	Cylinders No.	Cylinders Diam	Cylinders Stroke	Boiler pressure	Driver diam	Weight on drivers	Total weight locomotive running order	Heating surfaces Evaporative	Heating surfaces Superheater	Heating surfaces Total	Grate area	Track gage	Tender data Wheels	Tender data Fuel	Tender data Water	Weight 2/3 loaded
1	Lima	Virginian	2-8-4	F	2	26	34	245	69	295600	460400	4774	1932	6706	90	56½	12	21	25000	326800
2[a]	ALCO	N.Y.C.	4-8-4	F-P	2	25½	32	275	79	275000	485000	4819	2073	6890	101	56½	14	47	16000	331400
3	Rdg	Reading	4-8-4	F	2	27	32	240	70	278200	441300	4920	1214	6134	95	56½	12	26	19000	296700

TABLE 2 STEAM LOCOMOTIVES FOR FOREIGN SERVICE

Item	Builder	Owner	Wheel arrangement	Service	Cylinders No.	Cylinders Diam	Cylinders Stroke	Boiler pressure	Driver diam	Weight on drivers	Total weight locomotive running order	Heating surfaces Evaporative	Heating surfaces Superheater	Heating surfaces Total	Grate area	Track gage	Tender data Wheels	Tender data Fuel	Tender data Water	Weight 2/3 loaded
1	British	Southern	4-6-2	P-F	3	16½	24	280	74	110000	172000	2122	545	2667	38	56½	6	5	4500	68000
2	British	L.N.E.R.	4-6-2	P	3	19	26	250	72	132000	202000	2461	680	3141	50	56½	8	9	5000	100000
3[b]	Porter	Bel. Congo	2-8-2	F	2	19	22	200	48	106000	144000	1678	489	2167	42	Meter	8	600[e]	5000	57000
4	ALCO	Brazil	4-8-4	P	2	18	28	235	59	115000	216000	2054	652	2706	57	Meter	12	22	5300	141300
5[c]	British	Ceylon	2-6-2-2-6-2	F	4	16	22	185	43	150000	256000	1860	362	2222	45	66	..	7	4000	.....
6[d]	German	Germany	2-10-0	F	2	23½	26	225	55	179200	203800	1902	686	2588	42	56½	8	9	4200	158100
7	German	Germany	2-8-2	P	8	11¾	11¾	284	49¼	148000	216000	2582	1076	3658	49	56½	10	12	10000	132800

[a] Poppet-valve application.
[b] Wood burning.
[c] Tender built into locomotive.
[d] Condensing unit in tender.
[e] Cubic feet.

NOTES FOR TABLES 1 AND 2:
F = Freight. P = Passenger.
Fuel in tons (2000 lb). Water in U. S. gallons.
Boiler pressure expressed in pounds per square inch.
Weights expressed in pounds.
Heating surfaces and grate areas expressed in square feet.
Wheel diameters, gage and cylinder dimensions expressed in inches.
ALCO = American Locomotive Company.
Lima = Lima Locomotive Works.
Rdg = Reading Railway System.
Porter = H. K. Porter Company.
N.Y.C. = New York Central System.
Bel. Congo = Belgian Congo.
L.N.E.R. = London & North Eastern Railway.

American Locomotive Company during the year, and a twenty-sixth locomotive (Fig. 2 and item 2, Table 1) duplicate of its predecessors, except for the use of poppet-valve gear, was delivered to the railroad. Comparative tests between two locomotives of the Niagara type, one with the conventional Baker valve gear and the other with the poppet valves, are being conducted currently.

Fig. 3 illustrates the class T-1 locomotive built in the shops of the Reading Company for fast freight service on the Reading lines. Of the 30 constructed, all but one are equipped throughout with roller bearings on all axles. One locomotive of the lot has been equipped with crown-bearing journal boxes, fitted with Hennessy lubricators. Data are shown under item 3 of Table 1.

FOREIGN STEAM LOCOMOTIVES

Fig. 5 and item 1, Table 2, describes a Pacific 3-cylinder locomotive, 70 of which are under construction for the Southern Railway (England), to be used in pooled passenger and freight service, a trend in operating practice that parallels American pooling practices.

A 3-cylinder design for the London Northeastern is illustrated in Fig. 6 and described in item 2 of Table 2. Noteworthy in this design are the use of three independent valve gears, and the fact that the middle cylinder drives to the leading driving axle, with a consequent reduction in stresses in the center driving axle and main pins.

The Import-Export Industries Company of the Belgian Congo, Africa, has taken delivery of two 2-8-2-type wood-burning locomotives. They are described in item 3, Table 2, and are pictured in Fig. 7.

Fig. 8 shows one of 30 locomotives of the 4-8-4 type which have been built for the Brazilian National Department of Railways, and these are described in item 4, Table 2.

A Beyer-Garratt type, eight of which have been furnished for heavy-grade operations on a 66-in-gage line in Ceylon, is shown in Fig. 9 and described in item 5, Table 2.

Figs. 10 and 11, item 6 of Table 2, illustrate and describe the German condensing locomotive which was mentioned briefly without illustration or data in the 1944–1945 survey report.[2]

Another wartime development on the German railroads was a 2-8-2-type passenger locomotive which was driven by four V-type engines arranged alternately on the right and left sides of the locomotive, each of them acting on a single driving axle. Each engine consisted of two cylinders set at an angle of 90 deg. The stroke and diameter of each cylinder was approximately 11¾ in. A view of the locomotive with the lower streamlined shroud removed illustrates the running gear of this design, Fig. 12.

The builders of this locomotive claim that the maximum speed is 105 mph. The characteristics are shown in item 7 of Table 2.

FIRELESS STEAM LOCOMOTIVES

Two different designs of fireless steam switching locomotives are shown in Figs. 13 and 14. The first of these, an American design involving 600-lb tank pressure, was built by H. K. Porter Company for power-plant switching service. It develops a tractive force of 18,150 lb at 75 psi mean effective pressure. It has 108,000 lb on drivers and is capable of 25-mph maximum speed. The 0-6-0 locomotive built by the Vienna Locomotive Works (Austria) is unusual in that a storage-tank pressure of 1200 psi is utilized.

WELDED BOILERS

After approximately 9 years of successful operation of a trial

[2] "Progress in Railway Mechanical Engineering—1944–1945," MECHANICAL ENGINEERING, vol. 68, 1946, pp. 107–122.

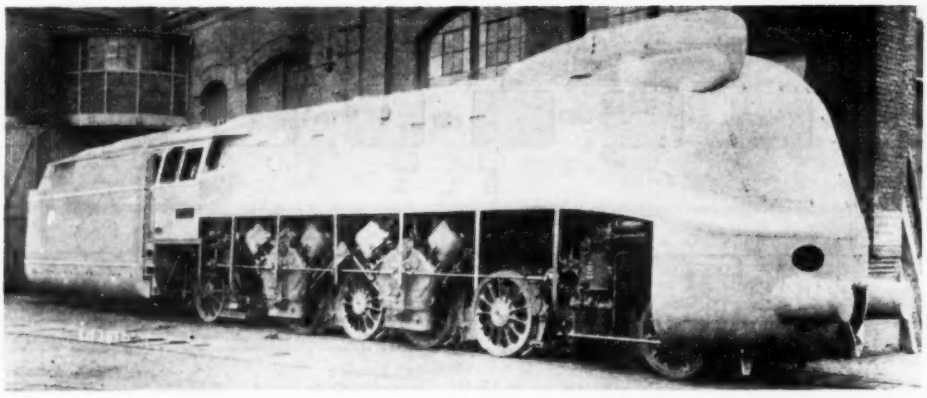

FIG. 12 GERMAN INDIVIDUAL AXLE-DRIVE LOCOMOTIVE

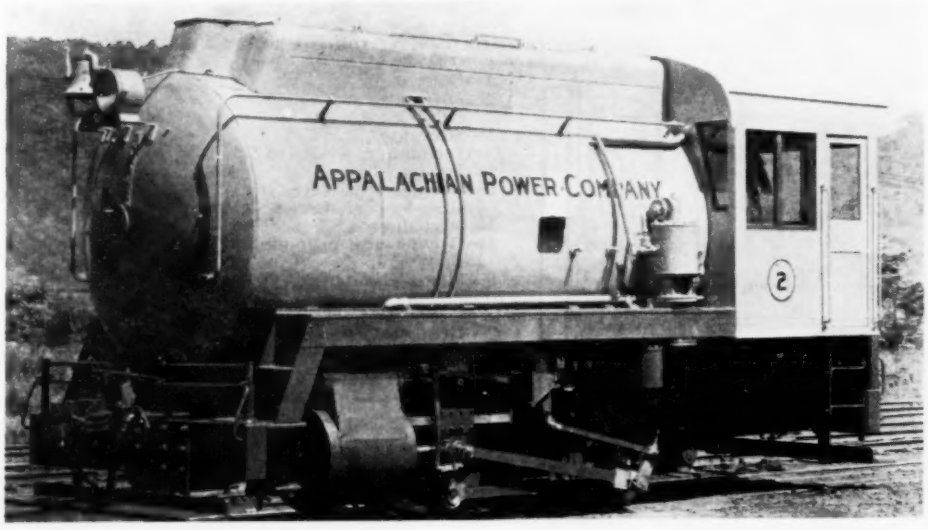

FIG. 13 AMERICAN FIRELESS STEAM SWITCHING LOCOMOTIVE

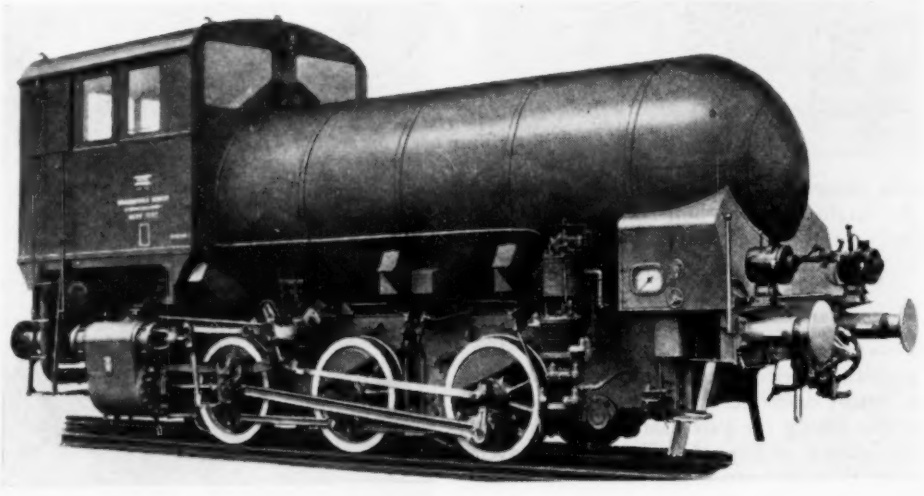

FIG. 14 AUSTRIAN FIRELESS STEAM SWITCHING LOCOMOTIVE

boiler on a Delaware & Hudson Consolidation, welded boilers were applied during the past year to two Canadian Pacific 4-6-2 locomotives. These are duplicates of 47 others supplied the C.P.R., except for the boiler construction. The fact that some 25 all-welded boilers are under construction for various roads at this writing indicates that this type of construction is on the

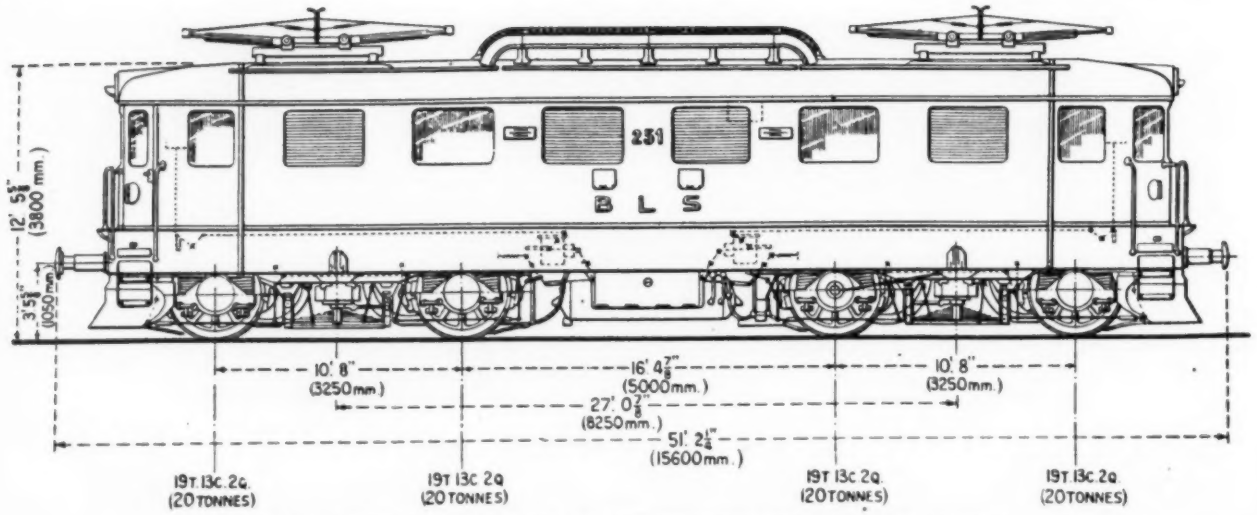

FIG. 15 GENERAL ARRANGEMENT OF LOCOMOTIVE FOR THE LOTSCHBERG RAILWAY

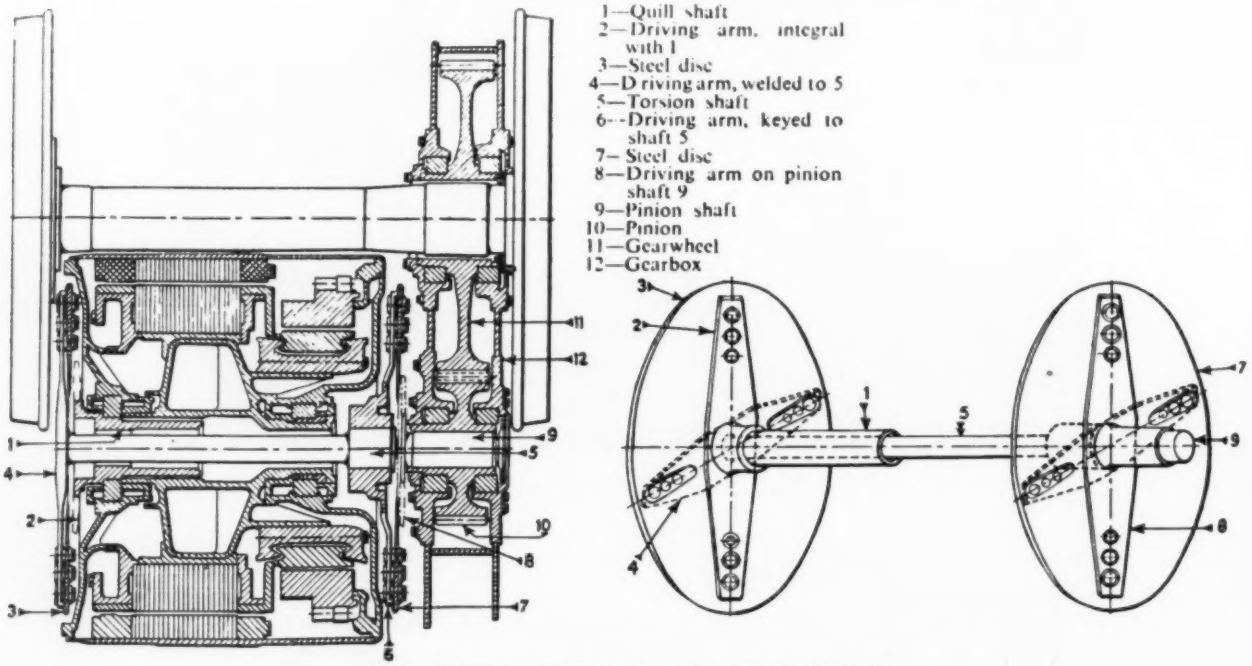

FIG. 16 FLEXIBLE-DISK DRIVE USED ON SWISS LOCOMOTIVE

way toward general acceptance by the railroads. Detailed descriptions[3] of the original D. & H. boiler have appeared in papers presented before the Society during the current year. The locomotive to which this boiler is applied is shown in Fig. 4.

ELECTRIC LOCOMOTIVES

Additional data covering the 4000-hp (1-hr rating) B-B electric locomotive, placed in service on the Lotschberg (Switzerland) Railway and briefly described in the 1944–1945 report,[2] have become available during the past year. Dimensions of the locomotive are shown in Fig. 15. The Brown Boveri flexible-disk drive and its incorporation in a motor-axle assembly are shown in the diagrams, Fig. 16.

[3] "Fusion-Welded Boiler on D. & H. Locomotive," by G. S. Edmonds, MECHANICAL ENGINEERING, vol. 68, July, 1946, pp. 619–621.
"Locomotive Boilers—Welded Construction," by James Partington, MECHANICAL ENGINEERING, vol. 68, July, 1946, pp. 622–624.

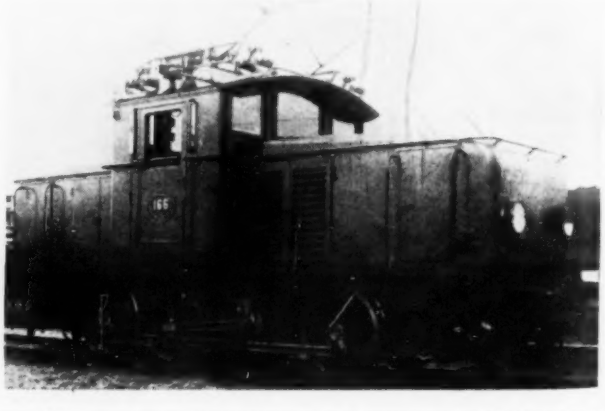

FIG. 17 SWITCHING LOCOMOTIVE FOR SWEDISH STATE RAILWAYS

TABLE 3 ELECTRIC LOCOMOTIVES FOR SERVICE IN SWEDEN

Item	Quantity built	See Fig. no.	Wheel arrangement	Service	Driving wheel diam, in.	Total locomotive weight, lb	Weight on drivers, lb	Maximum speed, mph	Notes
1	17	17	C	SW	$43^{5}/_{16}$	105000	105000	27	Geared jack shaft and side rods
2	11	..	B-B	F-P	$38^{3}/_{4}$	113000	113000	54	Axle-hung motors
3	12	..	B-B	F-P	$43^{5}/_{16}$	132000	132000	48	Axle-hung motors
4	4	18	B-B	F-P	$43^{5}/_{16}$	137000	137000	48	Quill drive
5	39	19	1-C-1	P	$60^{1}/_{4}$	177000	112000	60	Geared jack shaft and side rods
6	17	20	C-C	F-P	43.3	225000	225000	48	Quill drive
7	15	21	1-D-1	P	$60^{1}/_{4}$	225000	153000	81	Quill drive
8	8	22	B-B	SW	$31^{1}/_{2}$	137000	137000	48	Axle-hung motors

NOTES:
SW = Switching.
F = Freight.
P = Passenger.

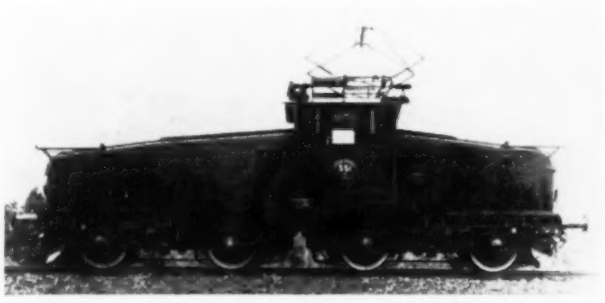

FIG. 18 ELECTRIC FREIGHT AND PASSENGER LOCOMOTIVE FOR SWEDEN

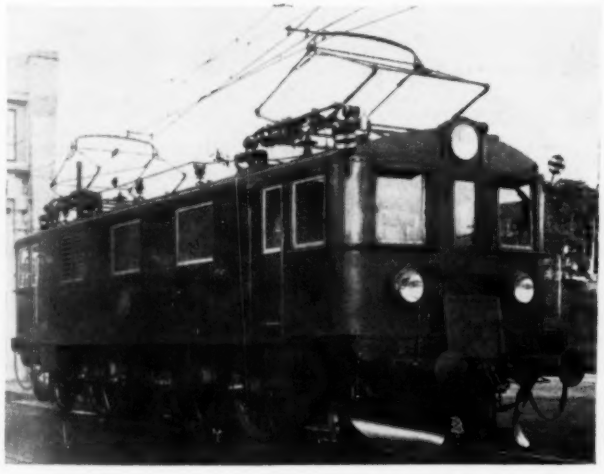

FIG. 19 PASSENGER LOCOMOTIVE FOR THE SWEDISH STATE RAILWAYS

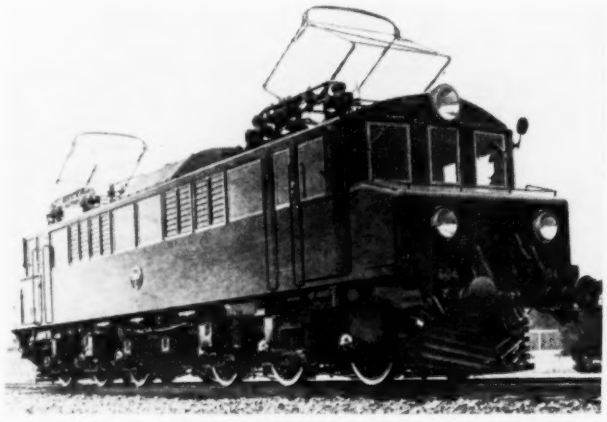

FIG. 20 C-C LOCOMOTIVE FOR USE IN SWEDEN

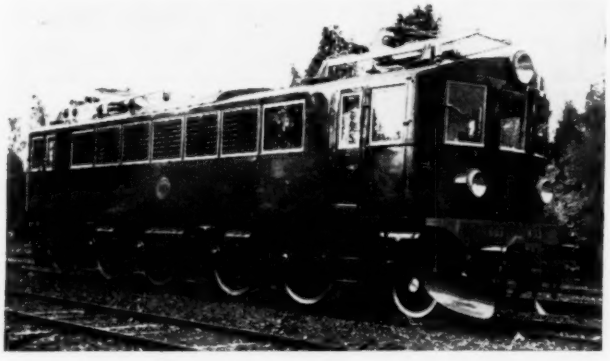

FIG. 21 1-D-1 PASSENGER LOCOMOTIVE FOR SWEDEN

During the war period, the Swedish State Railways placed in service a variety of 16,000-volt $16^{2}/_{3}$-cycle single-phase electric locomotives, the principal characteristics of which are shown in Table 3. With the exception of the relatively light switching unit, shown in Fig. 17, and the 2000-hp passenger unit, shown in Fig. 19, all of these locomotives were built with individual axle drive. The switching locomotive shown in Fig. 22 is a two-power machine carrying a storage battery for "off-line" and industrial spur operation.

Figs. 23 and 24 depict a 3000-hp 1500-volt d-c C-C locomotive built by Secheron in collaboration with the Swiss Locomotive Works (Winterthur) for service in Spain. The axle-hung traction motors utilize all-welded-fabricated frame construction, a departure from the more conventional form of cast-steel frame. A novel ventilating system is employed, wherein the traction-motor ventilating air, instead of being discharged to atmosphere from the motors, is carried back into the apparatus cab by a duct and discharged through the roof, after passing over and around the roof-mounted accelerating grids. Principal characteristics of the locomotive are as shown in Table 4.

TABLE 4 CHARACTERISTICS OF 3000-HP SWISS ELECTRIC LOCOMOTIVE FOR SERVICE IN SPAIN

Gage, in.	66
Total weight, lb	218000
One-hour ratings:	
Tractive effort, lb	37500
Speed, mph	30
Rail horsepower	3000
Continuous ratings:	
Tractive effort, lb	27500
Speed, mph	32.5
Rail horsepower	2400
Maximum starting tractive effort, lb	53000

FIG. 22 SWEDISH TWO-POWER SWITCHING LOCOMOTIVE

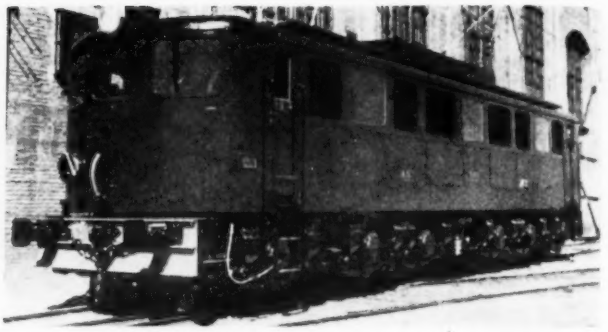

FIG. 23 1500-VOLT D-C LOCOMOTIVE FOR SPAIN

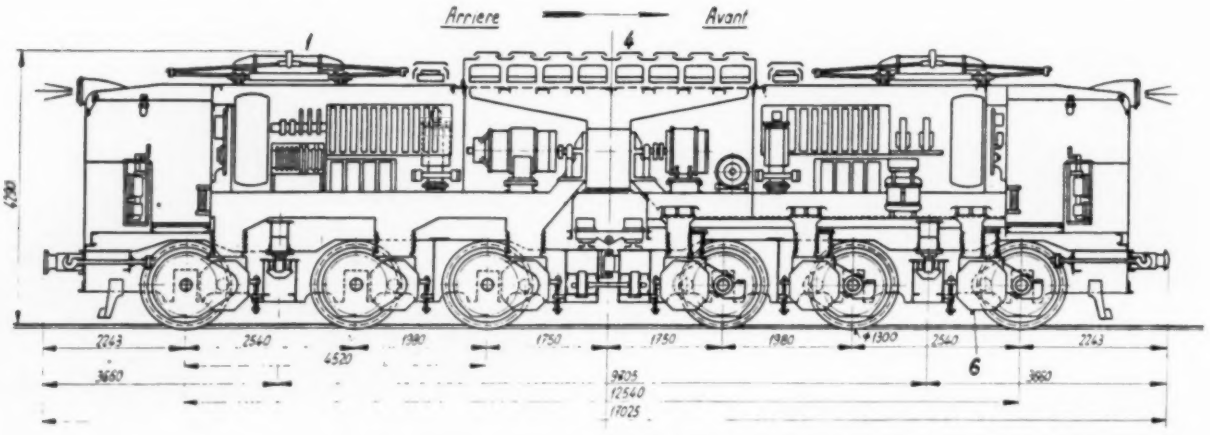

FIG. 24 VENTILATING SYSTEM FOR SPANISH LOCOMOTIVE

TABLE 5 DIESEL-ELECTRIC LOCOMOTIVES

	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7
Builder	ALCO	ALCO	Ingalls	F-M	Baldwin	Baldwin	Baldwin
Owner	A.T. & S.F.	....	.....	KCS	Seaboard	E.J. & E.	France
Wheel arrangement (per unit)	A1A-A1A	B-B	B-B	A1A-A1A	2-C + C-2	C-C	A1A-A1A
Number of units	3	3	1	4	1	1	1
Service	P	F	SW and road	F	F	SW and road	SW and road
Engine data:							
No. of engines (total)	3	3	1	4	2	2	1
Total horsepower rating	6000	4500	1650	8000	3000	2000	660
No. of cylinders (per engine)	16	12	8	10[a]	8	6	6
Bore and stroke, in.	9 × 10½	9 × 10½	12½ × 15	8½ × 10	12¾ × 15½	12¾ × 15½	12¾ × 15½
Speed, rpm	1000	1000	660	850	625	625	625
Cycles	4	4	4	2	4	4	4
Supercharged	Yes	Yes	Yes	No	Yes	Yes	No
Manufacturer	ALCO	ALCO	Superior	F-M	De La Vergne	De La Vergne	De La Vergne
Length over-all, ft-in.	195-5	154-8	59-1	259-10	92-0	71-0	58-0
Rigid wheel base, ft-in.	15-6	9-4	8-6	15-6	16-3	13-0	11-6
Total wheel base (one unit), ft-in.	49-8	36-6	42-6	51-11	77-10	51-3	43-9
Weight on drivers, lb	608000	683000	240000	928000	577200	360000	240000
Total locomotive weight, lb	912000	683000	240000	1316000	410000	360000	160000
Fuel capacity (total), gal	3600	3600	1000	6600	3500	1200	850
Driving wheel diam, in.	40	40	42	42	40	42	42
Track gage, in.	56½	56½	56½	56½	56½	56½	56½
Maximum permissible speed, mph	104	65	65	68	85	65	60

[a] Opposed-piston (two pistons per cylinder).

NOTES:
ALCO = American Locomotive Company.
F-M = Fairbanks, Morse & Company.
P = Passenger.
F = Freight.
SW = Switching.

DIESEL-ELECTRIC LOCOMOTIVES

During the year just passed several of the domestic locomotive builders introduced new models of road Diesel-electric locomotives.

Table 5 gives the salient dimensional and performance characteristics of the several locomotives discussed in the foregoing.

Fig. 25 illustrates a new 6000-hp passenger locomotive built by ALCO-GE for the Santa Fe, consisting of three cabs, each of which mounts a single 2000-hp supercharged 1000-rpm engine. Constant-pressure supercharging at approximately 20-psi pressure is employed with the new 16-cylinder V-engine. Item 1 of Table 5 gives pertinent data on this locomotive.

A companion locomotive to the new ALCO-GE passenger locomotive is the 4500-hp three-cab freight locomotive shown

FIG. 25 NEW ALCO-GE 6000-HP PASSENGER DIESEL-ELECTRIC LOCOMOTIVE

FIG. 26 ALCO-GE 4500-HP FREIGHT DIESEL-ELECTRIC LOCOMOTIVE

FIG. 27 1500-HP DIESEL-ELECTRIC LOCOMOTIVE WITH SUPERIOR ENGINE

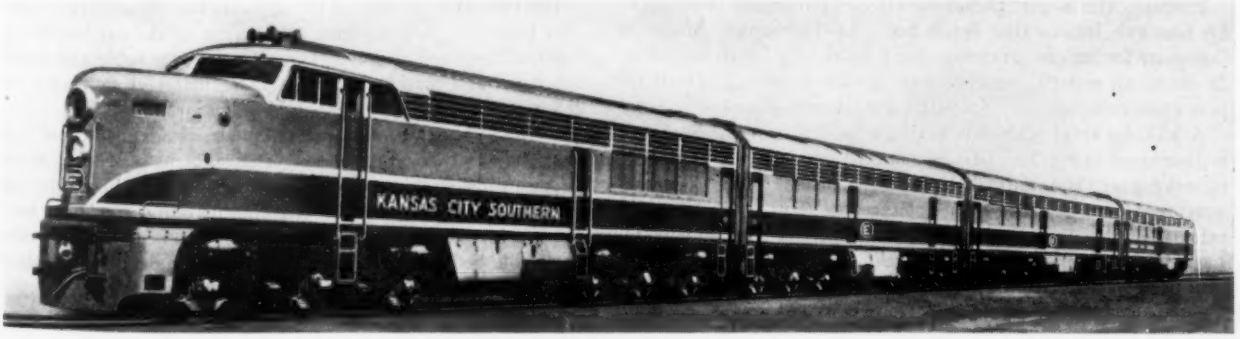

FIG. 28 FOUR-CAB 8000-HP FREIGHT DIESEL-ELECTRIC LOCOMOTIVE

FIG. 29 3000-HP, TWO-ENGINE, 2-D+D-2 DIESEL-ELECTRIC LOCOMOTIVE

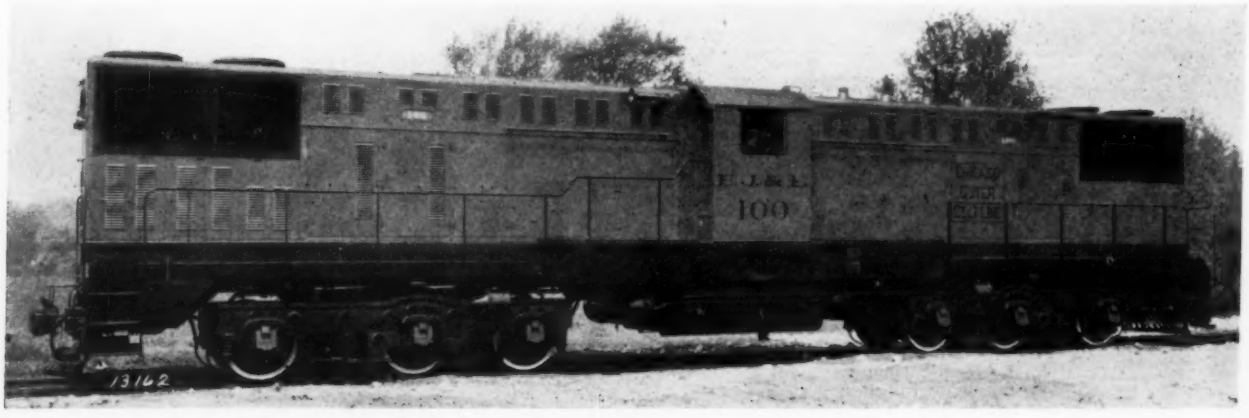

FIG. 30 BALDWIN 2000-HP TRANSFER LOCOMOTIVE

in Fig. 26, and described in item 2 of Table 5, with a 12-cylinder V-type engine embodying constant-pressure supercharging and cylinder dimensions identical with those in the 2000-hp engine.

A 1500-hp road-switching locomotive, manufactured by the Ingalls Shipbuilding Corporation, utilizing a 660-rpm 1650-bhp (150 hp of which is used for auxiliary drive) supercharged Superior Diesel engine, is shown in Fig. 27. Noteworthy in this design is the rear-vision windows in the operator's compartment and the vestibule type of step and entrance door at the rear of the cab. Details are given in item 3 of Table 5.

Probably the largest Diesel-electric yet purchased is the 8000-hp four-cab locomotive being built by Fairbanks, Morse & Company for freight service on the Kansas City Southern. Fig. 28 shows an artist's conception of the locomotive as it will appear upon completion. Statistics are given in item 4 of Table 5.

A 3000-hp single-cab unit built by Baldwin for the Seaboard is illustrated in Fig. 29. This locomotive, employing a 2-D + D-2 running gear, is a radical departure from the heretofore conventional type of road Diesel electric in service on American railroads. Mounting two 1500-hp supercharged 4-cycle De La Vergne engines, it is the largest single-cab Diesel-electric unit built to date (item 5 of Table 5).

The 2000-hp 2-engine locomotive shown in Fig. 30 is intended for heavy switching and road-transfer service. All six axles are motored. Characteristics are given in item 6 of Table 5.

The 660-hp locomotive shown in Fig. 31 was built by Baldwin for the French Supply Council for operation on lines where axle loading is restricted to 40,000 lb. Two axles in each of the three-axle trucks are motored (item 7 of Table 5).

RAILWAY-CAR CONSTRUCTION AND DEVELOPMENT

The past year witnessed the gradual but progressive change-over from war to peacetime production in the car building industry, hampered to some extent by labor trouble and increasing labor and material costs. Acute material shortages were general, particularly of steel and lumber.

In the utilization of materials and methods, the trend in design and fabrication of passenger equipment still leans toward streamlining, welding versus riveting, use of lightweight high-tensile structural materials, air conditioning, moderate use of plastics for trimmings, antifriction journal bearings, individual or double bedroom versus open sections in sleepers, fluorescent lighting, and numerous other improvements.

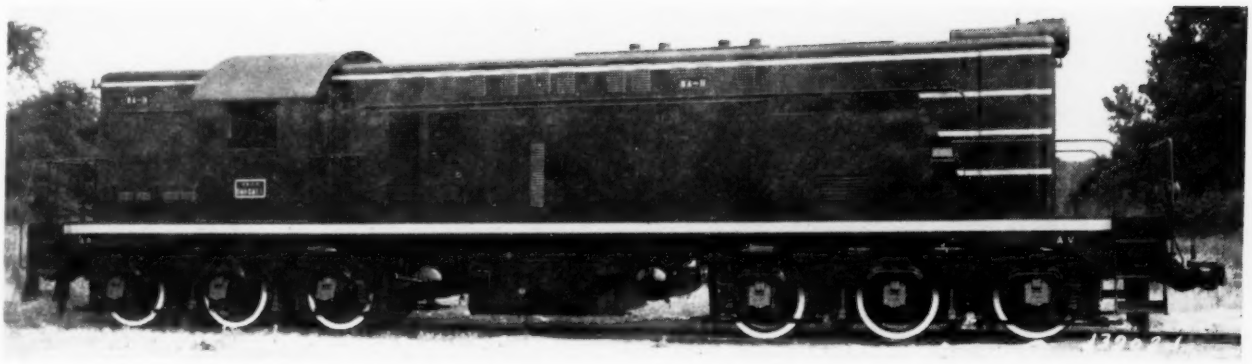

FIG. 31 SIX-AXLE 660-HP DIESEL-ELECTRIC LOCOMOTIVE FOR FRANCE

In the fabrication of freight equipment, developments utilizing lighter-weight materials, increased volumetric capacity, occasional use of tubular axles and compensating brakes have been common. In addition, vivid color schemes for highly advertised freight runs, quick-drying protective coatings, and specially designed trucks fitted with snubbers are indicative of recent developments.

The subsequent comments will deal with some of the more significant examples of construction during the past year.

An instruction car, designed and built at the Chattanooga Shops of the Southern Railway, is illustrated in Fig. 32. It is fitted with complete details of a locomotive Diesel engine which has certain parts cut away to show actual working conditions. Also included are the necessary electrical equipment and other accessories with appropriate explanatory charts for instructional purposes.

A substation car, illustrated in Fig. 33, was built by the General Electric Company for the Russian Government to be used for furnishing heat, light, and power to towns in Russia which were devastated by the war. Mounted on a flatcar, the entire unit weighs 111,000 lb and is rated at 1800 kva, with a high voltage of 35,000 which can be stepped down to 3150 or 6300 volts.

The Pressed Steel Car Company filled an order for 500 fifty-

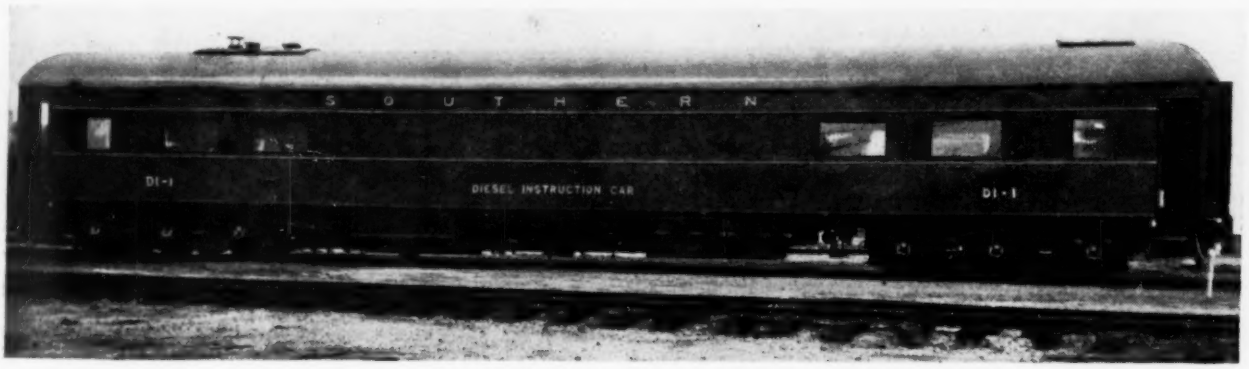

FIG. 32 DIESEL INSTRUCTION CAR FOR SOUTHERN RAILWAY

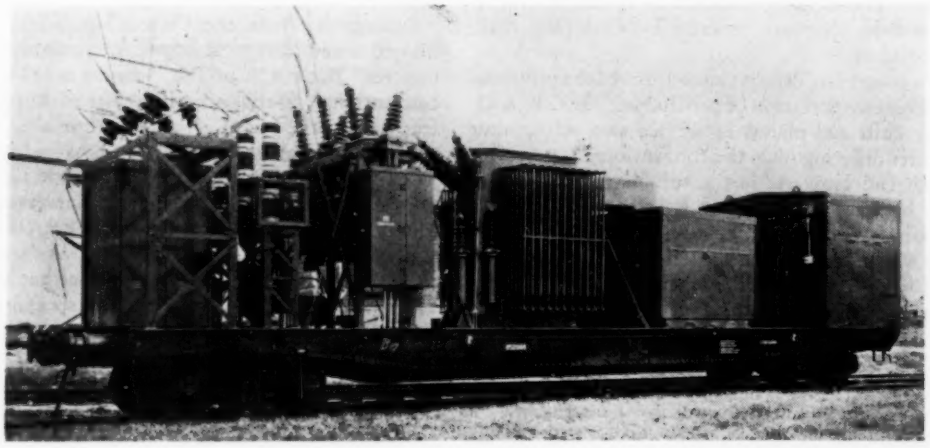

FIG. 33 GENERAL ELECTRIC SUBSTATION CAR FOR RUSSIA

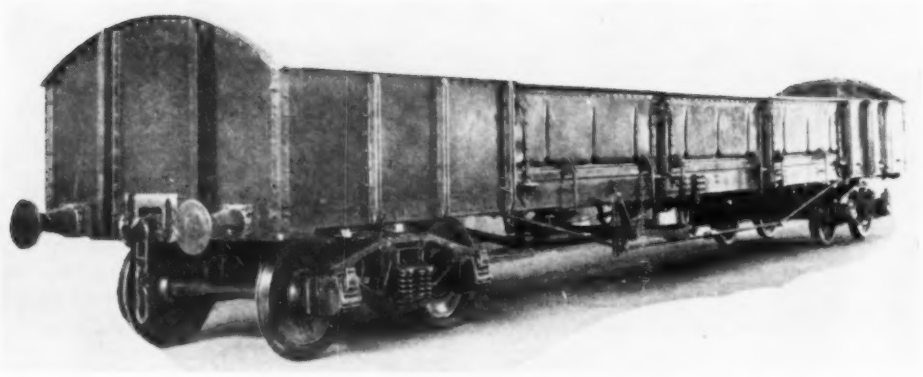

FIG. 34 GONDOLA CAR FOR PAULISTA RAILWAY OF BRAZIL

FIG. 35 LIGHTWEIGHT HOPPER CAR BUILT BY U. S. STEEL CORPORATION

ton drop-bottom all-welded general-service cars for the Great Northern Railway. By the use of five different high-tensile steels in the fabrication of this equipment, the total weight has been reduced to 42,000 lb, as compared to the 48,500-lb weight of an open-hearth steel-riveted gondola. A saving of 1426 lb was made by the use of "Ride-Control" trucks. Among several novel features is the Z-section A.A.R. center sill on top of which is welded a 10-in. section. "Unionmelt" automatic welding is used wherever possible with hand welding applied at inaccessible locations. The welding is tested by impact shock up to 16 mph. The drop doors are operated by a creeping shaft designed by the builders.

For the purpose of gaining definite knowledge of the problems encountered during transportation of perishables, the C.B. & Q. Railway recently built and placed in service two refrigerator cars having features differing from the conventional type. One car is fitted with end bunkers, has a volumetric capacity of 2067 cu ft with bunkers in place, and is fitted with "Preco" air-circulating fans and portable heaters. The lightweight of this car is 58,800 lb, and its ice capacity is 10,200 lb. The other car, fitted with overhead ice bunkers made by Standard Railway Equipment Company, utilizes natural air circulation and an underslung charcoal heater. This car has a volumetric capacity of 2263 cu ft and lightweight of 65,300 lb. The ice capacity is 8500 lb.

The American Car and Foundry Company has shipped 250 63-in-gage gondola cars to the Paulista Railway of Brazil. Fitted with 2-in. truss rods, screw couplings, mushroom buffers, and vacuum brakes, these cars are of all-steel riveted construction using A.A.R. Z-section center sills. The car, designed for a 42-metric-ton capacity with three drop doors on each side, has a lightweight of 40,700 lb. It is notable especially for the length of 50 ft 6 in., a length rarely required by foreign railroads. This car is illustrated in Fig. 34.

The National Steel Car Company of Hamilton, Ontario, has furnished the Canadian Pacific Railway with three experimental boxcars. They are fitted with lightweight aluminum sheathing roofs, running boards, hand-brake housing, and side doors.

During the year the United States Steel Corporation exhibited a new design of hopper car embodying several unique features. Built of "Cor-Ten," the car is 6540 lb lighter than the conventional 50-ton open-hearth-steel hopper. Outstanding features are the use of a tubular center sill and elimination of the inside brace extending from cross-ridge to side member. The lightweight of this car, illustrated in Fig. 35, is 33,500 lb.

In the railway tank-car field, the increasing use of corrosive alkalies and acids has intensified the search for materials from which to construct the tank. Steel is coated inside with an acid- or alkali-resistant coating of either metal or synthetic resin which is generally applied by spraying. An interesting departure from this method is the development, by the American Car & Foundry Company, of a 4000-gal fusion-welded tank of pure nickel for the transportation of phosphorus oxychloride and phosphorus trichloride.

The trend in passenger-car development has been toward comfort as exemplified by more comfortable seats, better light diffusion, use of improved designs of shock absorbers, and rest-

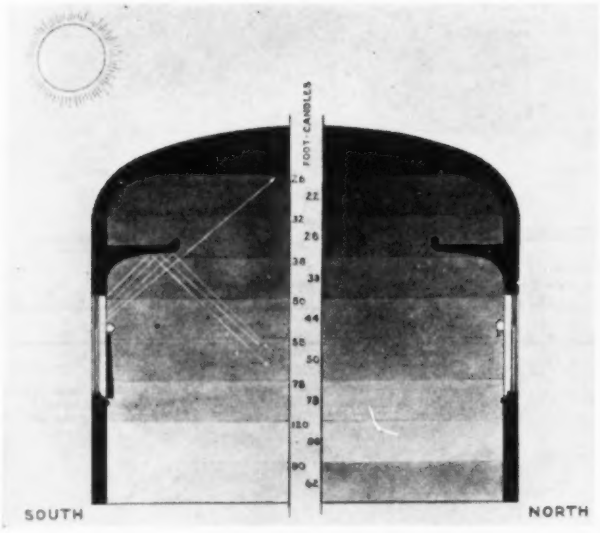

FIG. 36 "DAYFLECTOR" SYSTEM OF CAR LIGHTING

"black-light" illumination is brought about on the Santa Fe "El Capitan" by dyeing the carpets with special fluorescent dyes and subjecting them to ultraviolet rays giving illumination at floor level.

The Louisville & Nashville Railroad has taken delivery of four streamlined trains of seven cars each, built by the American Car & Foundry Company. Each train consists of a coach lounge car, a diner, a tavern lounge car, and four de-luxe coaches, as illustrated in Fig. 37. The cars are 85 ft in length over couplers, 10 ft wide over side posts, and 13 ft 6 in. in height. Approximately 34 per cent saving in weight over the conventional steel-construction cars has been effected by the use of aluminum alloy.

Each car has straight ends, the space between ends of adjoining cars being closed by rubber closures, giving a unit appearance to the entire train. The outside color scheme is royal blue and aluminum. All cars are air conditioned and fluorescent lighted, and the sides are well insulated.

Each truck includes four 36-in. steel wheels which are ground after mounting to insure smooth riding. The vertical and horizontal motion of truck bolsters is controlled by shock absorbers and rubber bolster anchors. Contact points between trucks and body are insulated with sound-deadening materials

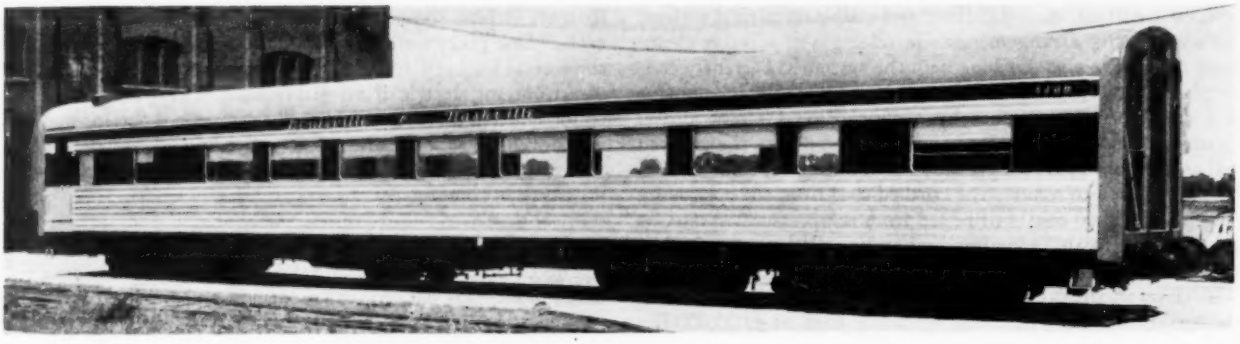

FIG. 37 LIGHTWEIGHT CAR BUILT FOR LOUISVILLE & NASHVILLE RAILROAD

ful interior color schemes. As a result of the survey conducted by Dr. E. A. Hooton of Harvard University, the Hayward-Wakefield Company designed a line of railway car seats, two being for day service and one for day-night use. The day-night seat has nine reclining-position adjustments, spring-actuated calf rest, a radio speaker adjustable by the occupant, and weighs 200 lb.

The recognized limitations of present-day car lighting induced the American Car & Foundry Company to give this matter special attention, resulting in the design of a new-type sash, bearing the name "Dayflector." It provides improved layout and design of the fluorescent-lighting fixtures which permit well-distributed lighting in daytime even if all curtains or window draperies are closed. The fluorescent tubes above the windows are placed in fixtures which deflect part of the light upward against the bright lower surface of the basket rack and thence downward. All wiring and sockets are in the fixture, eliminating the necessity for wiring inside the car framing. Window sash can be removed without disturbing light fixture.

Above the lighting fixture is a section between the outer and inner glass in which is placed a louver of horizontal slats so shaped and located as to deflect outside daylight upward against the bright lower surface of the basket rack, which in turn, deflects the light into the body of the car, as shown in Fig. 36.

Recent fluorescent-lighting developments include circular forms and straight fixtures up to 96 in. in length, resulting in more light with no increase in battery loads. The so-called

The E. G. Budd Manufacturing Company has under construction for the Missouri Pacific Railway an order of lightweight passenger cars, to three of which will be applied the so-called "astra-dome," a type of upper-deck construction permitting an unobstructed view in every direction. The dome, built into the roof structure, contains 12 elevated seats on each side, reached by a short stairway from the car floor level. Responsibility for this design is credited to the General Motors Corporation.

Pullman-Standard Car Manufacturing Company delivered in 1946, 60 new cars which will make up the streamlined "Empire Builder" trains between Chicago and the Pacific Northwest. Colors of the scenic Northwest and Indian scenes will be used in the decorative scheme.

HOTBOX ALARMS

To expedite discovery of "hotboxes" before the danger point is reached, especially in passenger service, several devices have been developed which give visible, audible, or olfactory warning when journal-box temperature exceeds a safe figure.

RESEARCH

The Locomotive Development Committee, of Bituminous Coal Research, continued its activities aimed at the development of a bituminous-coal-burning gas-turbine power plant for locomotive use. Work is being processed on the develop-

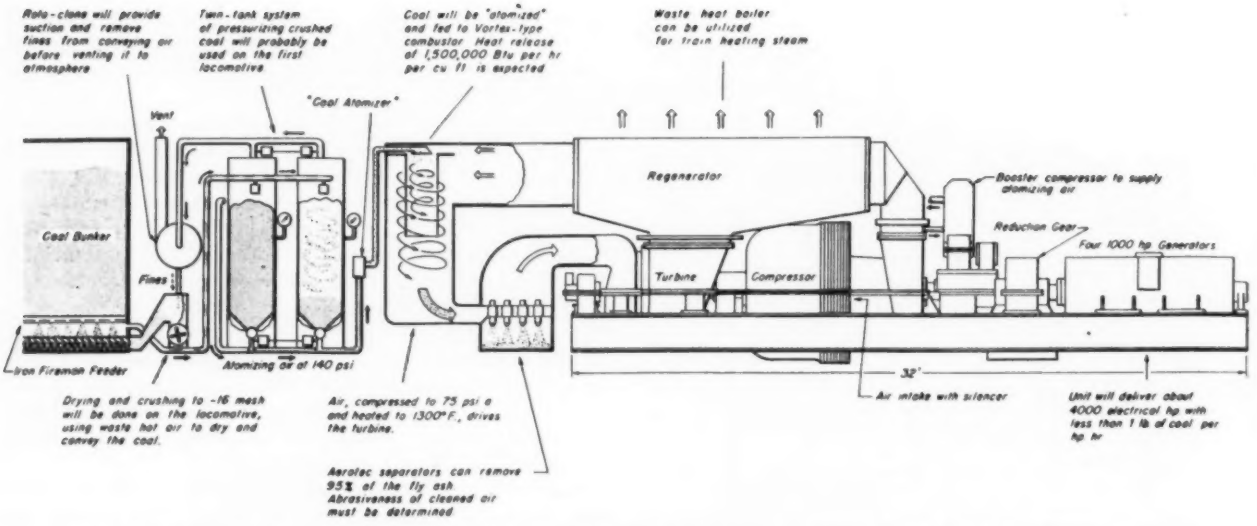
Rota-clone will provide suction and remove fines from conveying air before venting it to atmosphere
Twin-tank system of pressurizing crushed coal will probably be used on the first locomotive
Coal will be "atomized" and fed to Vortex-type combustor. Heat release of 1,500,000 Btu per hr per cu ft is expected
Waste heat boiler can be utilized for train heating steam
Vent
"Coal Atomizer"
Regenerator
Booster compressor to supply atomizing air
Reduction Gear
Four 1000 hp Generators
Coal Bunker
Fines
Turbine
Compressor
Iron Fireman Feeder
Atomizing Air at 140 psi
32'
Air intake with silencer
Unit will deliver about 4000 electrical hp with less than 1 lb of coal per hp hr
Drying and crushing to -16 mesh will be done on the locomotive, using waste hot air to dry and convey the coal.
Air, compressed to 75 psi a and heated to 1300°F, drives the turbine.
Aerotec separators can remove 95% of the fly ash. Abrasiveness of cleaned air must be determined

FIG. 38 DIAGRAMMATIC ARRANGEMENT OF COAL-HANDLING SYSTEM, COMBUSTION APPARATUS, AND POWER PLANT PROPOSED FOR B.C.R. COAL-BURNING GAS-TURBINE ELECTRIC LOCOMOTIVE

ment of a suitable coal-handling and coal-pulverizing system, and a combustor arrangement to provide gas of suitable cleanliness for feed to a gas-turbine. In the system as currently contemplated, raw coal will be fed from a bunker on the locomotive to a small primary crusher by a conventional screw feeder. Waste hot air from the turbine will be used to dry the crushed coal and to convey it to a pressurizing tank. A cyclone separator will be used to remove the crushed coal from the conveying air. The crushed coal will be fed from the pressurized tank as it is needed into an "atomizer" where it will be pulverized to an extreme fineness suitable for burning in the combustor.

Work on small-scale combustors is being processed at Battelle Memorial Institute where heat release as high as 4,000,000 Btu per hr per cu ft has been attained.

Because of the large amount of excess air used in the gas-turbine cycle, the problem of slag does not exist. Instead, fly ash is present and, to prevent turbine-blade erosion, removal of 95 per cent of such fly ash by a battery of "Aerotec" tubes has been accomplished.

The committee has placed orders with turbine manufacturers for two turbine-compressor-generator power plants of 3750 hp each. One plant will include an axial-flow compressor, while the second will utilize a centrifugal compressor. Conventional direct-current electric drive will be used in adapting these units to locomotive use. It is expected that each of the locomotives will develop 3000 hp at the rails.

Fig. 38 illustrates the projected system utilizing the axial-flow type of compressors.

ACKNOWLEDGMENT

The committee gratefully acknowledges the assistance rendered in securing data for the report, by the railway press of the United States, and in particular by the *Railway Gazette* of Great Britain; by the railroads, by the various American locomotive and car manufacturers; by the Locomotive Development Committee of the B.C.R.; by Secheron and Brown Boveri of Switzerland; by the Swedish State Railways; by the U. S. Department of Commerce; by Dr. Giesl-Geislingen of Austria; and by R. M. Coultas, General Electric Company, who assisted greatly in the compilation of the report.

Uses of Lignin in Agriculture

(Continued from page 198)

tilization of the atmosphere around crops from decomposition of soil organic matter, as suggested by Scarseth, opens up another interesting avenue for investigation.

It should be emphasized again that these experiments have been mainly of a preliminary nature and much more remains to be done before definite conclusions can be formed. In work of this type the experimenter is confronted with several difficulties which make progress slow. They are chiefly (*a*) relatively few plants can be grown at a time because of large space requirements; (*b*) the variability in individual plants themselves makes it necessary to repeat growth trials several times to be sure of results; (*c*) the large amount of care and labor involved, control of insects, diseases, etc.; (*d*) the variability of light and other climatic factors at different times of the year, and from year to year; (*f*) it would be desirable to have some microbiological investigations of soil and organic-matter relationships carried on in connection with these investigations.

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INTERNATIONAL 110s TYPICAL FLAT PLYWOOD SAILBOAT

PLYWOOD *in* BOAT CONSTRUCTION

By FRANCIS W. HAGERTY

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THE International 110 racing sailboat has been chosen as a basis for this discussion of plywood because it represents a constant in ten years of plywood small-boat construction. Making its appearance following the introduction of exterior plywood in 1935, it has been subjected to all climatic conditions likely to be encountered. The satisfactory performance of over 250 of these hulls scattered over this continent and the Pacific is ample evidence of the durability of this type of plywood-covered frame construction.

Earlier, many unsuccessful attempts had been made to produce waterproof plywood adhesives from blood albumen and casein. However, it remained for the introduction of phenolic adhesives to produce a waterproof panel. These resins, originally developed in Germany, were first produced by American companies in the mid-thirties.

The ideal marine plywood panel made with these adhesives should withstand prolonged exterior exposure in salt and fresh water, summer sun, and winter freezing, retaining at the same time its physical characteristics of high multidirectional strength, stiffness, resiliency, low moisture absorption, resistance to checking, and retention of paint finish. The resin adhesives used in these panels are permanently set under both heat and pressure in a bond that will prevent delamination after repeated wetting, drying, and exposure to severe temperature cycles.

Contributed by the Wood Industries Division and presented at the Fall Meeting, Boston, Mass., Sept. 30-Oct. 3, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Through the concentrated efforts of such organizations as the Douglas Fir Plywood Association, Forest Products Laboratory, Haskelite Manufacturing Corporation of Grand Rapids, Mich., Resinous Products Corporation of Philadelphia, Pa., and the United States Plywood Corporation of New York, N. Y., practical marine plywood panels were developed, manufactured, and marketed. Thus appeared a new material which was to overcome many of the production and structural problems of the boatbuilder—a material soon accepted as a classic in boatbuilding.

DISTRIBUTION OF STRESSES IN PLYWOOD

The efficient distribution of stresses so evident in a properly designed and well-built plywood boat is unknown in conventional plank construction. Because of its large area plywood can be effectively fastened and glued to a hull framework which it covers with few joints. Problems of calking and seasonal upkeep are eliminated. The negligible shrinking and swelling of the properly engineered plywood hull minimizes leaking, which is not only a source of structural trouble but the bane of the average small-boat owner whose yachting time is extremely limited.

As a result of distributed strength such previous essentials as timbers, floors, stringers, and interior finish are either reduced to a minimum or eliminated. The cross-plying of wood veneers in plywood tends to equalize the characteristics of wood in all directions and to minimize the inherent cross-grain weakness of wood. For maximum dimensional stability, there must be symmetry in cross section on either side of the core. The num-

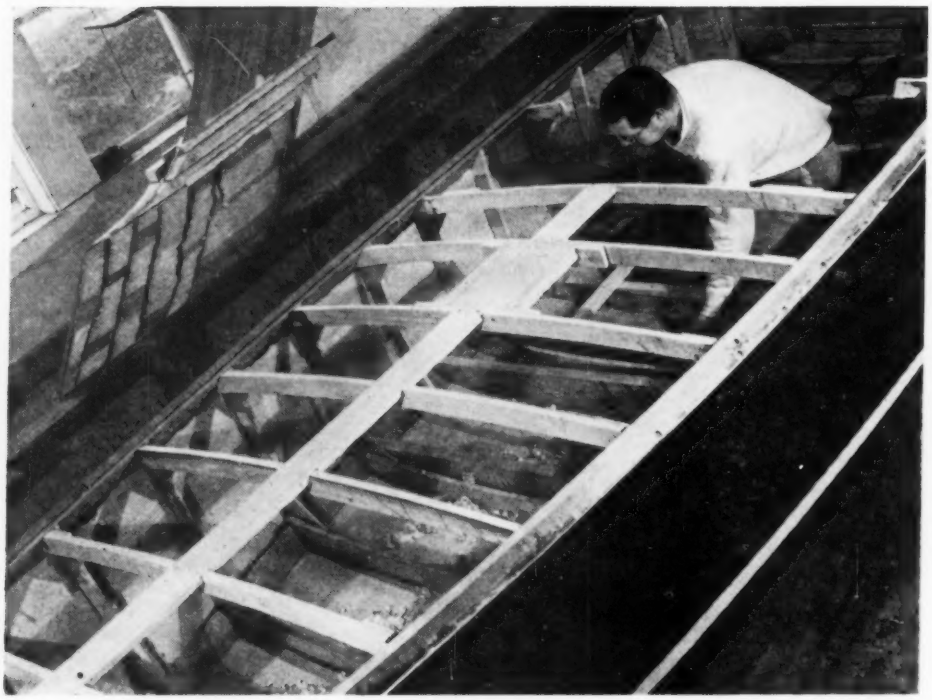

FIG. 1 TYPICAL HULL OF FLAT PLYWOOD ATTACHED TO FRAMES

ber, thickness, and species of wood should be the same. Since such a panel minimizes splitting, fastenings may be used along its edges.

The outstanding strength-to-weight ratio of plywood has suited it ideally to the manufacture of water craft from the light car-top dinghy in the small-boat field to the modern motor cruiser. The lightweight semifinished hulls of plywood boats make them relatively easy to handle with small-plant equipment. This is an extremely important factor if hulls have to be turned often for sanding and painting.

VENEER SELECTION FOR BOATBUILDING

In plywood designed for boat construction the face veneer as well as the cores should be cut from selected logs free from imperfections which might ultimately affect the structural quality of the panel. However, many woods, heretofore not adapted to boat construction because of their structural weaknesses, low resistance to abrasion, and lack of strength across the grain, can now be used. The primary essentials for such veneers are low moisture absorption, resistance to rot, strength parallel to the grain, and good gluing characteristics. Because of their oil content some woods successfully used in plank construction cannot be readily glued or used as a plywood veneer. Such imperfections as core voids, knots, splits, pitch pockets and other open defects should be avoided.

The face plies should be no greater than $^1/_8$ in. thick; the interior plies should be no thicker than $^3/_{16}$ in. Plywood made of thicker veneers is susceptible to wood failure at the glue line. In a series of experiments conducted on 8 × 8-in. samples of plywood and laminated wood glued with a resorcinal-type resin and exposed to winter and summer weathering for over two years it was evident that thickness of veneer as well as type of veneer is a factor in marine-plywood manufacture.

Mahogany and other equally valuable woods can be more economically used in plywood construction than they can in solid planking. First-quality flitches can be used as face veneers where maximum advantage is taken of the outstanding characteristics of the wood. This is an important factor because of the diminishing supply of the best grades of boat lumber.

In specific cases, where plywood must be adapted to cylindrical surfaces, a two-ply construction is most advantageous. The grain of the outer or thicker veneer will naturally run parallel to the axis of the cylinder. If cylindrical as well as compound curves are desired, as in the building of rowing shells, the thicker outer face can be selected from such low-density woods as Spanish or western red cedar. The inner or transverse veneers can be made of mahogany or some similar wood of lower density that will resist splitting.

To facilitate the curving of flat plywood there are many combinations of veneer layups that can best be arrived at through experimentation. Wherever possible sliced veneers are used for both core and face since they offer a better gluing surface, tend to reduce checking, possess increased stability, and have greater paint-retention qualities than rotary-cut veneers.

Sliced veneers are more expensive than rotary cut and their advantages must sometimes be sacrificed for economical reasons. The most popular and least expensive of the common flat plywoods manufactured from rotary-cut veneers is Douglas-fir exterior plywood. Over a billion square feet are produced annually by over thirty factories in the Pacific Northwest. These panels are made to the rigid requirements established by the Department of Commerce and explained in the United States Commercial Standard for fir plywood. The volume of this plywood is greater than that of all other plywoods produced.

ADHESIVE REQUIREMENTS

The waterproof adhesives used in all exterior fir plywood are of the phenolformaldehyde type set in hot-plate presses at a temperature of between 250 and 300 F, and at a pressure of nearly 175 psi. The bonding time varies greatly with the thickness of the panel but averages about five minutes. The introduction of high-frequency heating equipment has increased the speed with which thick panels may be produced. Since radio-frequency heating "cooks" the panel from the inside out, it is not affected by the insulating properties of wood, a detrimental factor in hot-plate bonding.

FIG. 2 LAYUP OF VENEERS PRIOR TO AUTOCLAVE BAKING
(By courtesy United States Plywood Corporation.)

Samples taken from the mass-produced panels are subjected to standard tests which include periods of soaking, drying, and boiling. These samples are finally shear-tested under a load of 600 to 1000 lb per min applied to the glue line. The ultimate failure must be in the wood rather than the glue line if the material is to be accepted.

STANDARD SIZES AND GRADES

The average mill manufactures fir plywood in standard panels measuring 4 × 8 ft. These can be scarf-joined together with the simplest of equipment to produce sheets of any desirable length. These panels are produced within a tolerance of 0.0156 in. of specified thickness. Standard thicknesses run from $^3/_{16}$ in. to $1^3/_{16}$ in.; thicker panels of various dimensions for special work are made to order.

Due to the exigencies of war and the lack of many strategic boatbuilding materials, exterior fir plywood was catapulted into a key position in the hurriedly expanding boatbuilding industry. Its well-earned reputation as a dependable and easily workable material made it indispensable to the production of the sturdy light craft that were built throughout the country almost overnight. Although these boats were built in haste and designed to be expendable, they were the backbone of strategic operations in almost all theaters of war and withstood effectively the rigors of climate and combat. There is no better proof of the stability of exterior plywood than its war record.

A new panel known as "exterior marine fir plywood" is now being manufactured. It is bonded with the same waterproof phenolic-resin adhesives as the "exterior" grade, but is built with selected face and core veneers which have better physical properties. Still in its experimental stage is another panel of "exterior marine" quality with faces of quartered fir or mahogany veneers designed to eliminate surface checking. A limited number of these panels were used during the war in aircraft and they measured up to the high standards of aircraft plywood.

RESIN-IMPREGNATED PLYWOOD

Fir panels with phenolic-type plastic-impregnated faces are now being mass-produced by at least five of the plywood factories in the Northwest. The plastic surface is obtained by bonding one or more sheets of plastic-impregnated paper to the faces of the panel during the process of manufacture. The result is a hard surface of polymerized plastic resins set under heat and pressure. Such a surface impregnation eliminates checking, offers much greater resistance to abrasion, and reduces or eliminates the cost of painting. Plans are now being made to produce these panels in various colors and with various types of surfaces.

Nonskid plywood was developed during the war and will have great application in deck construction where checking is most liable to appear. Some of these panels have a low enough surface resin content to allow for painting, but others with a greater percentage of impregnation are designed to be used without additional protection.

DESIGN ADVANTAGES OF FLAT PLYWOOD

Designers have taken advantage of the natural properties of flat plywood sheets, engineering their boats to the limitations of the material. The flat-plywood-covered frame hull shown in Fig. 1 is a happy combination of marine fir plywood and good design. The fir panels are adaptable to such surfaces having slight compound curves without torturing them into shapes alien to their inherent characteristics. However, the flat sheets of plywood are most adaptable to two fundamental forms, i.e., cylindrical or conical. It is highly desirable to keep compound curves at a minimum to avoid the setting up of stresses in the hull.

There is little doubt that the bent-plywood boat is the most adaptable to the small boatyard. The development of room-setting adhesives and mass-production techniques are responsible for the present popularity of this economical construction typified by thousand of dinghies, racing sailboats, motor yachts, and fishing vessels. The design potentialities of this simple form offer a challenge to the naval architect.

MOLDED PLYWOOD IN COMPOUND CURVATURE

The development of an increasingly economical material, molded plywood, has allowed the designer to leave the limi-

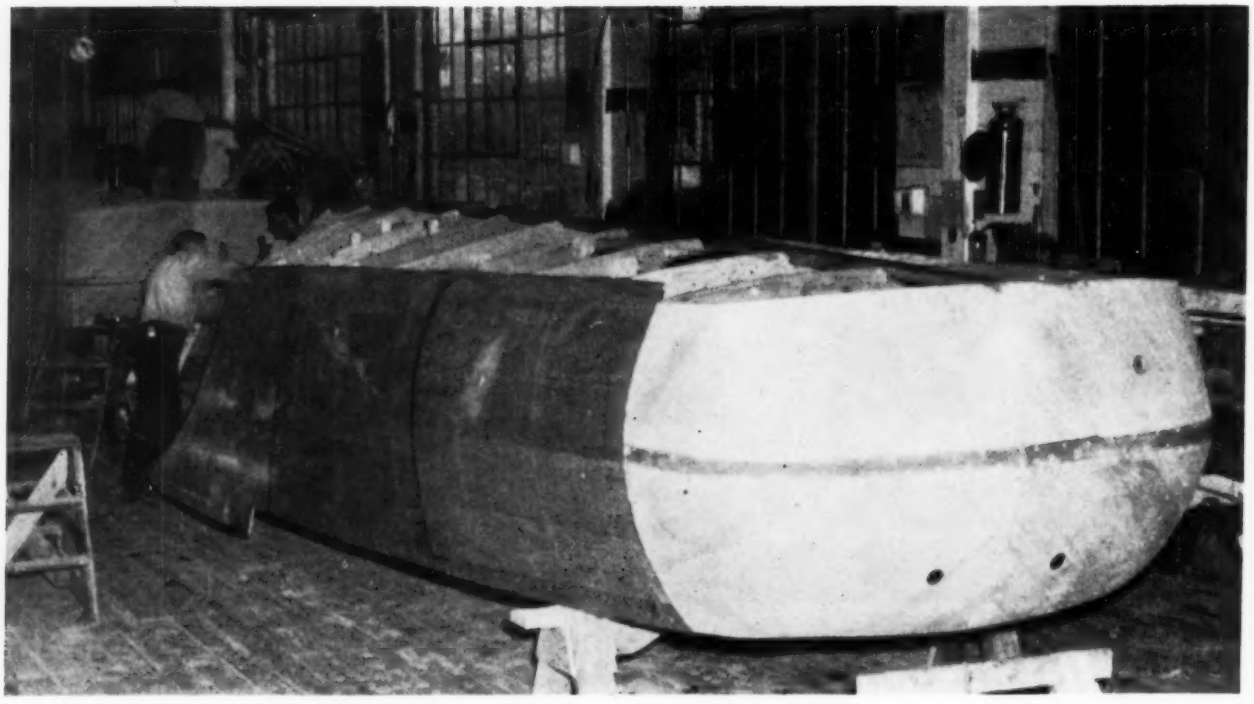

FIG. 3 ASSEMBLY SHOWING COMBINATION OF FLAT AND MOLDED PLYWOOD
(By courtesy Richardson Boat Company, Inc.)

tations of the flat plane and to run the full gamut of curves and shapes which represent the popular "eye appeal" of the times. The initial cost of essential molds for press or autoclave is relatively high and such an investment is warranted only when it can be amortized over a substantial volume of finished boats. Molded plywood differs from flat plywood in that it consists of individually shaped veneers bonded together on a mold with synthetic-resin adhesives under multidirectional pressure.

A common process of molding plywood consists of placing snugly fitting veneers covered with resin glue on a wooden male mold the size and shape of the interior of the finished product. The whole is placed in a rubber bag and the air exhausted. Heat and hydraulic pressure are applied over the surface of the bag in an autoclave or pressure chamber and the veneers are forced against one another and to the mold. When the glue is set the fluid pressure is relieved and the molded product is ready for the boatbuilder. The degree of compound curvature that can be achieved in such a process is limited by the curvature obtainable in the individual veneers.

It is obvious that a great deal of skilled hand labor is necessary in the proper shaping and laying up of veneers in such a process, Fig. 2. As long as such time-consuming painstaking work is necessary in the production of molded plywood shapes the cost will inevitably remain high. In spite of the shortcomings of this type of assembly and the inefficiency of autoclave molding, plywood in this form is economical when compared to its counterpart in solid lumber. As in any production program, savings can be made through the repetitive molding of similar shapes.

There are definite limitations to the thickness of plywood molded by the steam-autoclave process. These are attributable to the good insulating properties of both veneers themselves and the rubber bag. Excessive heating needed for production bonding of plywood thicker than $1/2$ in. reduces the life of the bags considerably and consequently increases the cost of the operation. High-frequency heating techniques make possible the production of greater thickness without serious increase in cost. Skin thicknesses of over $1/2$ in. are not encountered to any great extent since the consumer demand for large yachts is not great enough to warrant the use of any similar molding process.

DESIGN ADVANTAGES OF MOLDED PLYWOOD

The boating industry seized on the advantage of molded plywood not only because of its ability successfully to distribute torsional stresses caused by the action of seas in rough going, but also because of the similarity of mass-produced subassemblies. Identical moldings are easy to trim on simple jigs and fit uniformly in place on the hull.

The sailing-yacht designer and skipper see in this uniformity of molded plywood shapes the basis of a one-design dream. A successful one-design sailing class depends on a responsible racing association and a single licensed builder producing identical boats. For years one-design sailing programs have developed, flourished, and foundered because of the variations introduced by different builders presumably following a standard set of lines.

Now with the mass production of molded-plywood hulls competent builders throughout the country might purchase plywood shells from a common source and finish the hulls in strict conformance with definite regulations set up by an interested and able governing committee. Such a program could come very close to the ideal where construction is limited to one builder.

When the designer makes use of flat or molded plywood or both in combination, Fig. 3, he should specify in detail suitable assembly techniques for the proper handling of these materials. Success in any plywood-boat program is proportional to the techniques and quality of fabrication. It is important that both the designer and builder know the properties and limi-

tations of their materials, the kind of fastenings and their spacing, the types of adhesives or mastics and their application. On the proper interrelation of such factors as frames and their spacing, the plywood surface and its fastenings, hinges the success or failure of a hull.

SCARFED JOINTS

The development of room-setting waterproof and boilproof resorcinal adhesives has made possible the scarfing of plywood sheets and the effective joining of flat or molded plywood assemblies. Standard panels may be scarfed or joined to produce an area of any length or width. Scarfing is the process of beveling both edges to be bonded so that on overlapping they will produce a joint which has the same thickness as the plywood sheet. The length of the bevel or scarf should be approximately twelve times the thickness of the panel. Normally if scarfs are accurately fitted and properly glued they develop 80 per cent of the strength of the plywood panel. Such scarfed surfaces can be effectively glued together with the heat and pressure of a flexible bag.

A simple type of press for bonding scarfs that could be set up in any boatyard consists of a length of 4-in. fire hose, secured between the scarf joint and a restraining member. Hot water or low-pressure steam forced into the hose gives adequate heat and pressure for the setting of resorcinal-type resins. It is highly important that the sheets to be bonded be firmly clamped in position to prevent slipping.

ASSEMBLY TECHNIQUES

Because of the relatively large size and uniform thickness of standard sheets, plywood lends itself well to production cutting and assembly operations. Unlike conventional planking it is used with but little waste. Although in some instances there may be increased material costs, the labor saved in machining and fitting justifies the use of plywood in yacht and commercial boatbuilding.

There are several popular methods of applying the plywood skin to the hull framework. The most commonly used relies on the holding power of metal fastenings which secure the skin to mastic-covered frame and chine surfaces. In this construction all working stresses are distributed from the plywood skin to the hull framework through the metal fastenings. With nonadhering mastics which offer little or no holding power there may be a tendency for the plywood skin to move and work around the metal fastenings.

Another method preferred by some builders is the machining for bonding of all frame surfaces that meet the plywood skin. The skin is accurately fitted and glued with a resorcinal adhesive. This type of hull distributes stresses far more uniformly behaving like a monocoque unit. In this construction the metal fastenings are needed primarily to hold the plywood in place until the glue sets. In using an adhesive in place of a mastic the glued surfaces should touch at all points since any voids will result in a thick glue line having little strength. All wood and plywood should be carefully checked for uniformity of moisture content prior to gluing. The percentage of moisture should be between 8 and 14 per cent.

The war-emergency building program showed boatbuilders everywhere the advantages of such hand power tools as electric or pneumatic drills, saw, planes, and routers. Routers with wide surfacing bits and hand planes with rotary blades performed wonders of accurate fairing in hull assembly. Guided by jigs and fixtures they cut down assembly time at unbelievable rates and are today the backbone of many yacht-building operations. Specially tooled routers with fluted blades accurately cut layers of plywood sheets into duplicate deck panels, floor boards, webs, and bulkheads.

SIMPLICITY OF PLYWOOD REPAIRS

The plywood skin that has been fractured can be readily and simply repaired. All damaged or splintered veneers should be cut out leaving a hole with sound material on its perimeter. A plywood patch having the same thickness as the skin and the exact shape of the hole is inserted and bonded to an overlapping backing piece which is in turn bonded to the hull. Such a repair inevitably shows a patch on the inside of the boat but if the edges are beveled its appearance may not be objectionable. Repairs can be made that leave no trace by scarfing an inlaid piece to the beveled perimeter of the hole. This type of patch requires some skill and in the repair of molded plywood may necessitate the layup of a molded piece. Such a layup consists mainly of stapling glued veneers over a male form shaped to the damaged section of the hull. A bag of sand may be used as the female die as it gives an even distribution of pressure when laid over the veneers on the face of the form. In the event of gouging of the surface veneers, inserts or "dutchmen" can be inlaid and set in a waterproof adhesive.

SURFACE SEALERS

Of primary importance is the painting of the plywood boat both for its protection from weather and sales appeal. Much work was done during the war in the development of wood sealers and flake-aluminum base paints. It is believed that this type of flake-metal primer reflects much of the infrared and ultraviolet rays of the sun thus assisting in the preservation of the wood sealer. Such primers prevent excessive penetration of moisture and keep surface checking at a minimum.

MOLD AND INSECT DEPREDATIONS

In many sections of the world where marine life and fungus are a real problem, special treatment must be given to the interior of the plywood as well as to the surface. The best assurance is the pressure treatment of panels using cuprous and other salts as may be recommended by such organizations as the Clapp Laboratories in Duxbury, Mass., which have test stations all over the world. Although phenolic and resorcinal adhesives will not break down after prolonged exposure to fungus rot, they can be destroyed by some types of borers.

CONCLUSIONS

Because of the economies possible with plywood construction, the man of limited means now can afford the luxury and pleasure of sailing or motorboating. The 1946 yachting season has seen a tremendous increase of flat and molded plywood hulls for both sail and motorboat enthusiasts. An ever-increasing demand for these boats will inevitably lead to lower costs.

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Notes on SUBMARINE DESIGN

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AMONG the engineering professions, that of submarine design is one which claims a relatively small number of engineers but one which, in the enthusiasm of its members, concedes nothing to engineers in other fields.

The submarine designer, like any other naval architect, has the problems of surface speed, hull form, stability, weight distribution, hull strength, watertight subdivision, and general arrangements; but in addition to these, he must find solutions to the problem of submergence itself, propulsion while submerged, depth control, stability while submerged and through all stages of submergence and emergence, and a real space problem.

PROBLEM OF SUBMERGENCE

Let us consider, first, the problem of submergence itself. In principle it is simple enough. We just provide some tanks and let the sea water run into them until the weight of the ship, including the water, just equals its total displacement, being careful to stop when we have just the right amount, and being careful also that the distribution of the water is such that the ship remains upright and on an even keel. On one of our modern submarines we allow about 15 sec to take this water ballast aboard and, as it is coming in at a rate of about 2500 tons per min, it is manifestly impossible to exercise any control of its amount or distribution at the time of flooding. So the designer must exercise the control of the amount and distribution of the water ballast, and this he does by making the tanks of such size and so locating them that when they are full, the submarine has the right amount of weight added at the right place to give it neutral buoyancy when completely submerged. These tanks are called the main ballast tanks. Since they are always open to the sea, the internal pressure is equal to the sea pressure at all depths. Their external boundaries and divisional bulkheads therefore, may be of light construction.

Now the submerged displacement is almost a fixed quantity, varying only with the density of the sea water. This variation is so small (±0.5 per cent) that we may neglect it during submergence and correct the trim after submergence. Since, for submergence we always take in the same amount of water, it follows that the weight and longitudinal moment of the submarine must not be permitted to vary while the ship is on the surface. The tendency for her weight to vary exists for, like any other ship, she uses fuel, lubricating oil, fresh water, stores, provisions, ammunition, and torpedoes. This is not a small matter for the total of the variable weights is in excess of 500 tons for a submarine of 1500 tons standard displacement. The design must include means by which the crew of the submarine can compensate for these variations in weight.

The fuel is the largest variable weight and, since space is always at a premium, we make the fuel tanks do double duty and serve also as compensating water tanks. The fuel system is so designed that, in order to get fuel to the engines, water must be forced into the tank and this forces the fuel out of the tank and into the fuel-oil line. This is not difficult for, as the fuel floats, we put the compensating water in at the bottom of each tank and take fuel from the top. The salt water, being about 17 per cent heavier than the fuel it displaces, overcompensates, and, in so doing, assists in compensating for the expenditure of other consumable weights.

For the complete and accurate compensation of the net variations in weights and longitudinal moments, we provide another set of tanks, called the variable ballast tanks. These tanks are so distributed that they can be partly or completely filled with salt water to compensate for any reasonable variations in the expendable weights and their moments. Since the fuel tanks are always completely filled with a liquid, we can make the pressure in them equal to sea pressure and then build the tanks of light material. The pressure is maintained equal to sea pressure by keeping the compensating water line open to all fuel tanks at all times and providing a connection from the sea to the compensating water line. A valve in the fuel line to each tank provides all necessary control for transferring fuel.

In these days of fast airplanes there is distinct advantage in getting a submarine completely submerged and out of sight before an enemy airplane can get close enough to do some pinpoint bombing. We can speed up the submerging operation by having the submarine go ahead through the water with the bow depressed; and to get the bow depressed, we deliberately submerge it first by designing the main-ballast-tank flooding holes and vents so that the flooding time for the forward tanks is only about one half as long as for the aftertanks.

To get the main ballast tanks flooded in their allotted 15 sec requires some special consideration. We could and, until about 4 years ago, did provide flood valves so that we could control the flooding; but when we need about 200 sq ft of flooding area, this required many rather large-sized valves as well as a means for getting them opened quickly, which involved complications. When the war came along and the submariners decided not to bother with opening and closing the flood valves but just to leave them open all the time, the way was cleared to omit the valves and we now cut flooding holes in the bottoms of the tanks. The vent valves were, of course, retained and furnished all the control that was needed. By opening the vent valves the tanks can be flooded and by closing the vent valves and introducing the air into the tanks, the water is forced out the bottom.

When a submarine is running on the surface, there must be several openings in the hull, which are as follows:

(*a*) An air induction valve to supply air, about 30,000 cfm to the engines and for ventilating the ship and the storage batteries.

(*b*) An exhaust valve for each engine that is running.

(*c*) A hatch to enable the bridge watch, 5 or 6 men, or more if the guns on the bridge are manned, to get below.

(*d*) A second hatch or door if the guns on the main deck are manned.

(*e*) An ammunition-passing scuttle if the guns are in use.

SEQUENCE OF DIVING OPERATIONS

To make a dive, certain operations are necessary:

1 Sound the diving alarm so there will be nobody who "didn't get the word."

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NOTE: Opinions or assertions contained in this paper are those of the author and are not to be construed as official or reflecting the views of the Navy Department or of the Naval Service at large.

2 Stop the engines.

3 Close the engine exhaust valves as soon as the engines are almost stopped. Indicators on these valves signal the control room that the engines have stopped.

4 Close the air induction valves.

These operations must be performed in the sequence named. Meanwhile other operations are going on as follows:

5 Open the main-ballast-tank vents.

6 Bridge watch and gun crews get below, the last man closing the hatch.

7 Close ammunition scuttle, if open.

8 Disconnect engines from shafts.

9 Go ahead on the main motors.

10 Rig out the bow planes and place at "hard dive."

11 Release compressed air to show that the ship has been sealed. (The barometer will begin to show an increase in pressure when the last opening is closed).

As the main deck will go under in about 25 sec and as there must be no mistakes, you may be sure that the designers of the individual parts, their operating gears, controls, and indicators expend no small effort in their design and convenient arrangement, and in testing them thoroughly when it becomes desirable to make a departure from the previous design of any one of these features.

If the reader were in command of a submarine making an approach on an enemy target and found, when he attempted to take his last look, that his diving officer had gone so deep he could not see through a periscope, he would appreciate the desirability of having not only a good diving officer, but a submarine that a good diving officer could keep at the correct depth.

The designer must provide that kind of a submarine even though it is essential to have one that will not vary by more than 6 in. from the desired depth in a smooth sea while making not more than 2 knots, a speed which a surface ship does not even look upon as steerage way. In a choppy seaway, especially with whitecaps, it is not necessary to be so particular, for the periscope would be harder to see, and risk of exposing more of the periscope or a higher speed would not be great.

DESIGNING THE CONTROL PLANES

To make possible this desired degree of accuracy of depth control, it is conventional to provide a set of hydroplanes near the bow and another set near the stern. With this as a starting point, the designer now has only to analyze the performance of previously designed submarines which had good, or indifferent, or bad depth control, decide upon the area, shape, speed of operation, method of control, exact location and method of support, and then design the planes and the operating mechanism.

In our Navy there is a further complication in the case of the bow planes as we design them to be folded flat against the sides of the ship when not in use, so they will not pound against the surface of the water. Yet the planes and their operating mechanism must be designed so that they will not be damaged if they are rigged out on the surface and do pound the surface. An attempt to determine the load so imposed by direct calculation is futile, for it would involve many assumptions which would be little better than guesses. So here again we fall back on analyses of the planes on previous submarines, including those which have failed as well as those which have not failed, and arrive at an equivalent permissible loading per square foot. It is not a small load and, for our 1500-ton submarine, it amounts to a total load of 120,000 lb for the bow planes. The stern planes are placed just abaft the propellers, and this permits them to be made smaller than would otherwise be possible, as they are in a stream of water which is moving at a higher velocity than the water at any other place.

The bow planes are used for small changes in depth while the stern planes are used to control the inclination of the ship. For large or rapid changes in depth the stern planes are the most effective. In that case they are used to incline the ship upward or downward, and the forward motion then changes the depth.

The bow planes also serve a useful purpose which could not be accomplished by the stern planes in connection with the firing of torpedoes. If a salvo of 6 torpedoes is fired from the bow, we have suddenly removed 9 tons of weight from the bow. Its effect is to make the bow try to come to the surface. We minimize this tendency by flooding the torpedo tubes as rapidly as possible, thus regaining a part of the lost weight; but, in order to prevent broaching, the bow planes must be put at hard dive when firing is commenced and held there until full depth control is regained.

There is one more feature which is provided for depth control. It is a tank forward of amidships which is normally empty but which can be flooded quickly and which is used when it is necessary to prevent broaching or to go deep without delay. We call this tank the "negative tank" because it gives the ship negative buoyancy. The British call it the "down express," a more descriptive term. It is emptied as the ship approaches the desired depth. The negative tank may be flooded on the surface to make the submarine initially heavy, which decreases the diving time slightly. It is then emptied by compressed air as soon as the ship is submerged.

STRENGTH OF HULL STRUCTURE

The problem of the strength of the hull differs entirely from that of a surface ship. Instead of a pressure of about 15 psi, which is the maximum to which the bottom of a surface vessel is exposed, the submarine must be designed to withstand a pressure of several hundred pounds per square inch acting on all parts of the hull. This requires a rather lengthy calculation for every frame of the ship, and careful placing of the material in the shell and frames to keep the stresses at all points near but not in excess of the acceptable limit. It also requires the most meticulous care in designing all closures and points of discontinuity for we are working with a factor of safety of 1.5, about the smallest used by any engineer. The Marbec method is used for the strength calculations, and as it is too theoretical to make the designer entirely happy, we usually make and test to destruction a reduced-size model of those parts of the ships which depart materially in shape from other models which have been tested.

Longitudinal strength is not a serious problem as it is in surface ships. Except in the largest submarines which have been built, the stresses do not approach the permissible limits.

Compartmentization is a relatively simple matter in a long cylindrical ship. Transverse bulkheads are provided to divide the ship into compartments, any one of which may be flooded without sinking the ship, provided she is not submerged at the time. One of our submarines during the war flooded a compartment while submerged. She landed on the bottom almost immediately but the crew was able to bring her to the surface and to the nearest friendly port, over 2000 miles. There have been several cases where a compartment has been flooded while a submarine was on the surface, and the bulkheads saved the ship from sinking. The design of the bulkheads, because of the pressure involved and of the necessity for keeping the weight within reasonable limits, is based upon formulas derived from many tests of small-scale bulkheads rather than on the usual beam formulas.

The most difficult prob'em has been the design of a door which must be able to withstand the required pressure in either direction. We had a very good test of one submarine door in 1939 when the *Squalus* sank. This door was exposed to a

pressure of 105 psi in the direction which tended to unseat it, and the total leakage in the 113 days before the ship was raised was only a few gallons. Since that time it has been necessary to change the design of the doors to make them suitable for more than twice this pressure. As now being used, the door can be closed and secured in 3 sec by one man against a total force of 140,000 lb.

STABILITY CALCULATIONS

Stability is always a matter of concern to the naval architect. If he is working on the design of a surface ship, he calculates with considerable accuracy the heights of the center of gravity and the center of buoyancy in the various conditions of loading he expects the ship to encounter and then adjusts the beam to give him the desired metacentric height. This statement makes the process sound simpler than it really is, for if his original estimate of the beam was not a reasonably good one, he might find it necessary to alter the lines to such an extent that he must recalculate the position of his centers of buoyancy and of weight. However, he still is able to obtain the desired stability characteristics by choosing a favorable breadth at the water line.

On the other hand, the submarine designer must obtain satisfactory stability with the ship submerged. Then there is no water line and a change in the beam has no effect on stability. Furthermore, the parts of the submarine which are not fully flooded must be essentially circular in section so they will withstand the required pressures. So the only factor available for him to work on to get the desired stability when submerged is the position of the center of gravity. Nobody has ever succeeded in getting too much stability submerged, so all efforts are directed toward keeping the heavy components as low as practicable. Even the lighter items such as pipe lines and electric cables are placed as low as the available space permits. Those items which are too bulky or which must be readily accessible to the operating stations are screened carefully to be sure they have been made as light as they can be. This latter is very important and must be borne in mind during the development of all the working plans.

Not many years ago one of our submarine design yards was rather hard-pressed in the drafting room to get the plans prepared by the time they were needed and relaxed somewhat its efforts to keep the structure and fittings near the top of the ship as light as might have been possible. As a result, the stability of the ships of that class was less than the designed stability and barely above the acceptable minimum. Later in their lives these ships could not be given all the alterations which were found desirable under war conditions and, before the close of the war, were withdrawn from combat and used for training.

This incident brought forcibly to the attention of that yard the necessity for meticulous care in the design of each part, and the saving of weight was a serious consideration during all stages of the design of the following class. That this care paid dividends was well established by the fact that the actual weight of this class was about 100 tons less than the original designed weights. As previously stated, a given submarine must be kept at a constant displacement, so it was necessary to add 100 tons of ballast before these submarines could operate. This ballast could be placed at the bottom of the ship where it would lower the center of gravity and increase the stability. The stability exceeded the requirements by a considerable amount, and 100 tons seems like a lot of extra ballast.

This margin of weight and stability was obtained at the most opportune moment, just before the 1940 building program. All of the submarines built during the war were built to this design with slight modifications from time to time. Whenever a new device was invented or developed that would increase the effectiveness of the submarine, and they nearly always meant an increase in weight, we had the weight available merely by removing some of the ballast. Never during the war was there any concern about a submarine being deficient in stability or overweight. Nor was it ever necessary to decline to make a desirable change in the design because we could not tolerate the additional weight. Continued attention to weight in the detail design maintained this very satisfactory position even until the war ended.

All of the foregoing considerations pertain to the stability when submerged. It is still necessary to provide satisfactory stability on the surface, and this is accomplished in the same way it is done on any other surface ship.

ALMOST CONSTANT CHANGE IN DETAILS

In 1940, when orders were placed for a fairly large number of submarines, the designers felt that they had a very satisfactory design which was ready for production in quantity. Yet, as the war progressed, it became more and more apparent that what they actually had was a very satisfactory starting point for the continuous development of the design.

Mention has been made of the fact that changes were made during the war. There were no basic changes, for the shape of the hull and the same general arrangement were used for all submarines built during the war. However, the author finds it difficult to think of a single part that did not undergo at least one change in design. Of the hundreds of changes, some of the principal ones may be mentioned as follows:

Two 5-in. and two 40-mm guns were substituted for one 3-in. and two 50-caliber machine guns.

The crew was increased from 54 to 70 and the additional required berths and lockers were added.

The number of officers was doubled and the required accommodations were provided.

Four additional torpedoes were provided.

The fuel capacity was increased by 20 per cent.

Three radar sets were added and each of these was changed at least once to keep up with the rapid developments.

The strength of the hull and its resistance to underwater explosions was greatly increased. This required new designs for all fittings subject to pressure, as well as for the entire structure of the ship.

The main motors and their controls were radically changed.

The diving time was reduced by one third.

The capacity of the air-conditioning plant was increased by 50 per cent.

The reasons for some of these changes are obvious, but the consideration which caused the most numerous changes of individual parts was that of the production of underwater noise. This required the careful study of every moving part, and eventually, every such part was changed to make it less noisy. If ever a designer was repaid for his efforts, this was the time, for the amount of noise produced by a submarine at the end of the war was only 1 per cent of that produced at the beginning of the war.

No discussion of the subject of submarine design would be complete without mention of the part played by the operating personnel. Every designer knows that his most valuable source of information is the criticism of his customers. Unlike most customers, however, the submariners know their ships thoroughly, both in principle and in detail, how every part works, and how to fix it when it doesn't work properly With such a background it is not surprising that their criticism was almost invariably constructive. Without such constructive criticism, it is difficult to believe that the submarine could have been developed into a weapon as effective as it has proved to be.

THE NATIONAL FUEL RESERVES

Relation to the Future Supply of Liquid Fuels

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RESERVES OF MINERAL FUELS

THE United States is fortunate in having large reserves of all kinds of mineral fuels in solid, liquid, and gaseous forms. The coal reserves, excluding those of Alaska, but including lignite, are estimated by the Federal Geological Survey at 3.2 trillion net tons as of January 1, 1937.[2] This amount is thought to be from 40 to 50 per cent of the world reserves of all ranks of coal. The proved reserves of petroleum in the United States as of January 1, 1946, are estimated at 20.8 billion barrels by the Committee on Petroleum Reserves of the American Petroleum Institute.[3] This figure is about 35 per cent of the proved world reserves.[4] The proved reserves of natural gas have been estimated at not less than 135 trillion cubic feet as of January 1, 1945, by James E. Pew of the Petroleum Administration for War.[5] Very little data are available on the world reserves of natural gas.

In addition to these fuel reserves, Winchester has estimated a potential reserve of 92 billion barrels of oil obtainable from the distillation of oil shale in the United States.[6] This amount is more than 4 times the present proved petroleum reserve.

Attention is called to an important difference between the estimates of reserves of natural gas and petroleum on the one hand and solid fuels on the other. Only the proved reserves are given for liquid and gaseous fuels. These are increased each year by new discoveries and extensions of fields and are decreased by the year's production. Since 1940 the petroleum reserve has increased only 2 billion barrels. During the same period the estimates of natural-gas reserves have increased from 80 to 135 or more trillion cubic feet. Undoubtedly, much more oil and gas will be discovered in the United States, and in this respect these fuels differ from coal and oil shale. The solid-fuel reserves are estimated from geological observations and measurements of thickness and extent of deposits obtained from surface outcrops, trenching, exploratory tunnels, shafts, and drill cores. No great accuracy can be claimed for these estimates, but future exploration is not likely to add greatly to the solid-fuel reserves. Some geologists believe that revisions will be downward as more detailed exploration or development data are obtained in the various fields.

No estimate of national energy resources can be complete without considering fissionable materials and the future development of industrial heat and power from them. A group of American scientists in a report to Bernard M. Baruch, U. S. representative on the United Nations Atomic Energy Commission, released on September 7, 1946, estimated that the operating cost of atomic power for industrial use would be only 23 per cent more than in a modern public-utility plant using coal costing $7 a ton. With coal at $10 a ton, the operating costs would be the same. This report was based on studies made under the direction of Dr. Charles A. Thomas,[7] vice-president and technical director of the Monsanto Chemical Company. It was estimated that a nuclear power plant of 75,000 kw capacity could be built and equipped for $25,000,000 and that the operating cost, including 3 per cent interest on investment, would be 0.80 cent per kwhr, as compared to a coal plant of the same capacity costing $10,000,000 for installation and 0.65 cent per kwhr for operation.

While this cost is too high to compete with coal under present conditions, it is reasonable to expect material lowering of cost will follow from an energetic research program on the industrial utilization of atomic energy. It is probable that safe and economical central-station power ultimately will be developed on a commercial basis, and it also may prove feasible for driving large ships; but in the absence of radically new developments, small and mobile power and heating plants will continue to need our present forms of mineral fuels.

Information is not available on the national reserves of fissionable materials—uranium and thorium. On the basis of 1600 tons of coal being equivalent to 1 lb of fissionable uranium products, only about 800,000 tons of the latter are required to be equivalent to the national reserve of 3.2 trillion tons of coal.

All evidence points to very much larger reserves of coal than of oil and gas, as shown in Table 1 and Fig. 1, where all the mineral fuels are expressed in equivalent tons of coal of 13,000 Btu per lb calorific value. The total of all ranks of coal amounts to approximately 2600 billions of tons of 13,000-Btu coal, whereas the proved petroleum reserve is equivalent in heating value to only 4.8 billion tons of coal, and the proved natural-gas reserve is equivalent to 5.2 billion tons. Excluding fissionable materials, coal comprises 98.8 per cent of our mineral fuel energy reserves. Oil shale amounts to 0.8 per cent, petroleum to 0.2 per cent, and natural gas to 0.2 per cent. While we cannot forecast further discoveries of oil and gas, it appears on the basis of present knowledge that the ultimate reserves of oil and gas will be very small as compared to the reserves of coal and lignite. As the supply of oil and natural gas declines below the demand, it will be necessary to resort to coal and other sources of energy either by direct substitution or by conversion of the solid fuels to liquid and gaseous forms. Fuel gases from coal by carbonization or complete gasification have long been in commercial use, and in recent years commercial

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[1] Chief, Fuels and Explosives Branch. Presented by permission of the Director, Bureau of Mines.

[2] "Energy Resources and National Policy," Report of Energy Resources Committee to National Resources Committee, Government Printing Office, Washington, D. C., January, 1939; chapt. 1, "Coal Reserves," by T. A. Hendricks, pp. 281–286.

[3] "Proved U. S. Crude-Oil Reserve Totals 20,826,813,000 Barrels," *A.P.I. Quarterly*, April, 1946, pp. 24–26.

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[5] "Natural Gas and Its Products During the War," by James E. Pew, Petroleum in War and Peace, 1945, p. 124.

[6] "The Oil Possibilities of the Oil Shales of the United States," by D. E. Winchester, Federal Oil Conservation Board, Report II, January, 1928, pp. 13–14.

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[7] "Nonmilitary Uses of Atomic Energy," by C. A. Thomas, *Chemical and Engineering News*, vol. 24, Sept. 25, 1946, pp. 2480–2483.

TABLE 1 ESTIMATED MINERAL-FUEL RESERVES OF THE UNITED STATES

Description	Reserve Jan. 1, 1946	Assumed annual production	Equivalent billions of net tons, bituminous coal, 13,000 Btu per lb calorific value[a] Reserve Jan. 1, 1946	Per cent of total fuel reserves	Assumed annual production	Reserve divided by annual production plus loss[b]
1	2	3	4	5	6	7
Anthracite, billions of net tons	15	0.060	15	0.6	0.059	165
Low-volatile bituminous coal, billions of net tons[c]	52	0.115	56	2.2	0.124	317
High-volatile bituminous coal, billions of net tons[c]	1351	0.467	1403	54.2	0.485	2024
Subbituminous coal, billions of net tons	818	0.014	598	23.1	0.010	....
Lignite, billions of net tons	939	0.004	484	18.7	0.002	....
Total, all ranks of coal, billions of net tons	3175	0.660	2556	98.8	0.680	2595
Petroleum, billions of barrels[d]	20.8	1.7	4.8	0.2	0.392	12.3
Oil from oil shale	92	1.7	21.2	0.8	0.392[e]	54.1
Natural gas, trillions of cu ft[d]	135	4.0	5.2	0.2	0.154	34
Total, all fuels.			2587		1.226	1700

[a] Heating values used in conversion: Anthracite, 12,700 Btu per lb; low-volatile bituminous coal, 14,000 Btu per lb; high-volatile bituminous coal, 13,500 Btu per lb; subbituminous coal, 9500 Btu per lb; lignite, 6700 Btu per lb; crude petroleum, 6,000,000 Btu per bbl; natural gas, 1000 Btu per cu ft.

[b] Recovery of 65 per cent is assumed for anthracite and 70 per cent for all other coals and lignite.

[c] Includes some medium-volatile coal.

[d] Proved reserves only.

[e] Not included in total.

processes have been developed for the conversion of coals to liquid fuels by the direct hydrogenation of coal or hydrogenation of tars or gases produced from coal.

RESERVES OF VARIOUS RANKS OF COAL

The minimum thickness of beds included in the Geological Survey estimate of reserves is 14 in. for bituminous and anthracitic coals, 2 ft for subbituminous coal, and 3 ft for lignite. Coal beds lying more than 3000 ft below the surface were not included in the estimates. There is comparatively little coal in the United States that would require mining at depths beyond 3000 ft. The estimated coal reserves do not allow for losses in mining; that is, they are not limited to recoverable coal, as is the case with the petroleum and natural-gas estimates. In computing the life of a reserve based on an assumed annual production as given in column 7 of Table 1, allowance was made

TABLE 2 PERCENTAGES OF VARIOUS RANKS OF COAL COMPRISING TOTAL COAL RESERVES OF THE UNITED STATES

	Per cent of total coal reserves in equivalent tons of 13,000-Btu coal
Anthracite coal	0.5
Low-volatile bituminous coal	2.5
High-volatile bituminous coal	55
Subbituminous coal	23
Lignite	19
Total	100

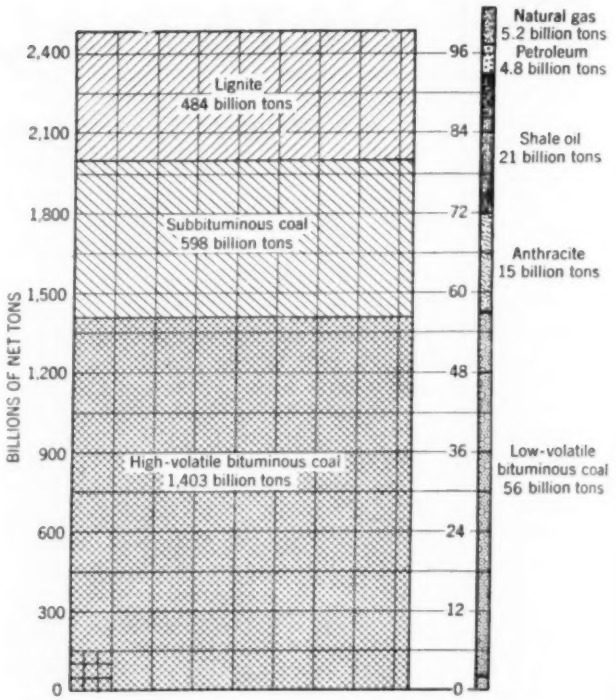

FIG. 1 ESTIMATED MINERAL-FUEL RESOURCES OF THE UNITED STATES AS OF JANUARY 1, 1946, AND EXPRESSED IN EQUIVALENT TONS OF BITUMINOUS COAL OF 13,000 BTU PER LB CALORIFIC VALUE (Medium-volatile bituminous coal is distributed between high- and low-volatile coal. 1 small square = 2 billion tons.)

TABLE 3 ESTIMATED COAL RESERVES OF UNITED STATES, 1936,[a] IN BILLIONS OF NET TONS

Order of reserves	State	Anthracite	Bituminous coal	Subbituminous coal	Lignite	Equivalent bituminous coal
	Alabama		66.6			69.0
	Idaho and Oregon		0.7	1.8		2.0
	Arkansas	0.2	1.3			1.5
3	Colorado	0.1	212.6	104.0		297.0
	Georgia		0.9			1.0
5	Illinois		197.8			205.0
	Indiana		52.0			54.0
	Iowa		28.7			30.0
	Kansas		29.7			31.0
7	Kentucky		121.5			126.0
	Maryland		7.7			8.0
	Michigan		1.9			2.0
	Missouri		83.7			87.0
4	Montana		2.6	62.9	315.5	211.0
	New Mexico		18.8	1.9		21.0
	North Carolina		0.1			0.1
2	North Dakota				600.0	309.0
	Ohio		92.0			96.0
	Oklahoma		54.8			57.0
8	Pennsylvania	14.6	103.3			121.0
	South Dakota				1.0	0.5
	Tennessee		25.3			26.0
	Texas		8.0		22.9	20.0
	Utah		88.0	5.2		95.0
	Virginia	0.5	20.6			22.0
	Washington		11.2	52.4		50.0
6	West Virginia		147.7			155.0
1	Wyoming		30.3	590.0		462.0
	Total	15.4	1407.8	818.2	939.4	2559.1

[a] Statement of W. E. Wrather, Director, U. S. Geological Survey: Hearings on Synthetic Liquid Fuels before a Subcommittee of the Committee on Public Lands and Surveys, U. S. Senate, 78th Congress, 1st Session, 1943, p. 98.

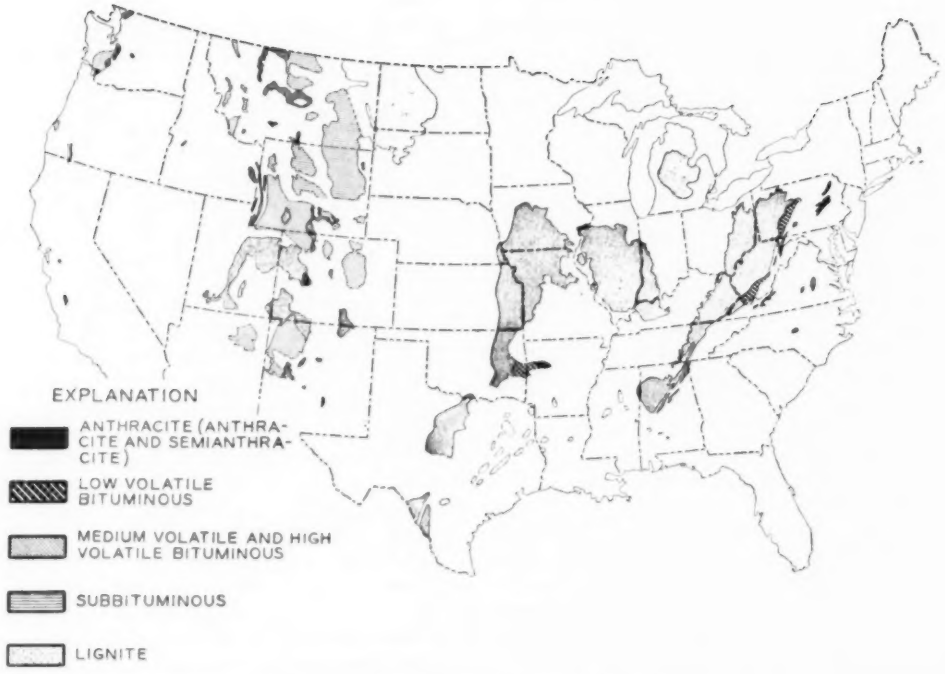

FIG. 2 COAL FIELDS OF THE UNITED STATES
(Prepared by the Geological Survey, Department of the Interior.)

for 35 per cent mining losses for anthracite and 30 per cent for bituminous coal and lignite.

On the basis of energy content, the total coal reserves are distributed among the different ranks of coal in the proportions indicated in Table 2. The reserves of these coals in net tons of each rank for the various states as estimated by the Federal Geological Survey are given in Table 3.

From the standpoint of regional distribution, the principal reserves are grouped in the Eastern Province (Fig. 2) consisting of Pennsylvania, Ohio, Maryland, West Virginia, Virginia, eastern Kentucky, Tennessee, and Alabama; the Interior Province, consisting of Illinois, Indiana, western Kentucky (comprising the eastern region of this province), and Iowa, Missouri, eastern Kansas, Oklahoma, and Arkansas (comprising the Western region); and the northern Great Plains, Gulf, and Rocky Mountain Provinces, extending from North Dakota and Montana through Wyoming, Colorado, Utah, and New Mexico and including Texas. The reserves of these provinces are summarized in Table 4.

Only one third of the total tonnage of coal and lignite reserves occurs in the Eastern and Interior Provinces. Two thirds is found in the Great Plains and Rocky Mountain Provinces. However, there is a great difference in rank between the eastern and western coals. Practically all of the Eastern and Interior Province coals, except the anthracitic coals, are caking bituminous coals; and the Appalachian region coals are strongly coking. This region supplies most of the coking coals used in the United States. On the other hand, 80 per cent of the Great Plains and Rocky Mountain Province coals are subbituminous coals and lignite. These coals do not cake on heating. As mined, lignite usually contains 28 to 45 per cent and subbituminous coal 15 to 28 per cent moisture. On exposure to air, the moisture is given off and the coal "slacks" into small pieces. It is not stable and cannot be stored for any length of time except under water, in carefully covered piles, or in closed bins where rapid loss of moisture cannot take place.

Lignite and subbituminous coals are used for industrial and domestic fuel in the Dakotas, Montana, Wyoming, Colorado, and western Nebraska. However, the total market is small because of the low density of population in these areas, and these low-rank fuels cannot be shipped very far on account of their low heating value and their tendency to degrade in size with accompanying possibility of spontaneous ignition.

TABLE 4 COAL RESERVES OF VARIOUS RANKS DISTRIBUTED BY PROVINCES

Provinces	Billions of net tons				
	Anthracitic coal	Bituminous coal	Subbituminous coal	Lignite	Totals
Eastern	15.1	525.2			540.3
Interior	0.2	508.0		0.1	508.3
Northern Great Plains, Rocky Mountain, and Gulf	0.1	360.3	763.9	939.4	2063.7
Totals	15.4	1393.5	763.9	939.5	3112.3

Most of the bituminous coal in the western states is free-burning and noncaking. Relatively small deposits of coals suitable for the production of metallurgical coke occur in the Trinidad-Raton field of southern Colorado and northern New Mexico, the Sunnyside beds in the Castlegate field of Utah, and in Pierce and Kittitas Counties, Washington. Some of the coals are slightly caking but do not become plastic enough to form coke that is sufficiently strong for use in the iron blast furnace. In general, anthracite, and coking coals of metallurgical grade occur in the Eastern Province, coking coals of lower grade and lower bituminous rank in the Interior Province, and noncaking coals of lignitic, subbituminous, and bituminous rank in the Great Plains and Rocky Mountain Provinces.

Fig. 3 shows the coal reserves by states. The amount in each state, expressed in equivalent tons of 13,000-Btu bituminous coal, is proportional to the height of the column erected in the state. The white space represents lignite, the vertical cross-hatching subbituminous coal, the inclined cross-hatching bituminous coal, and the solid black represents anthracite.

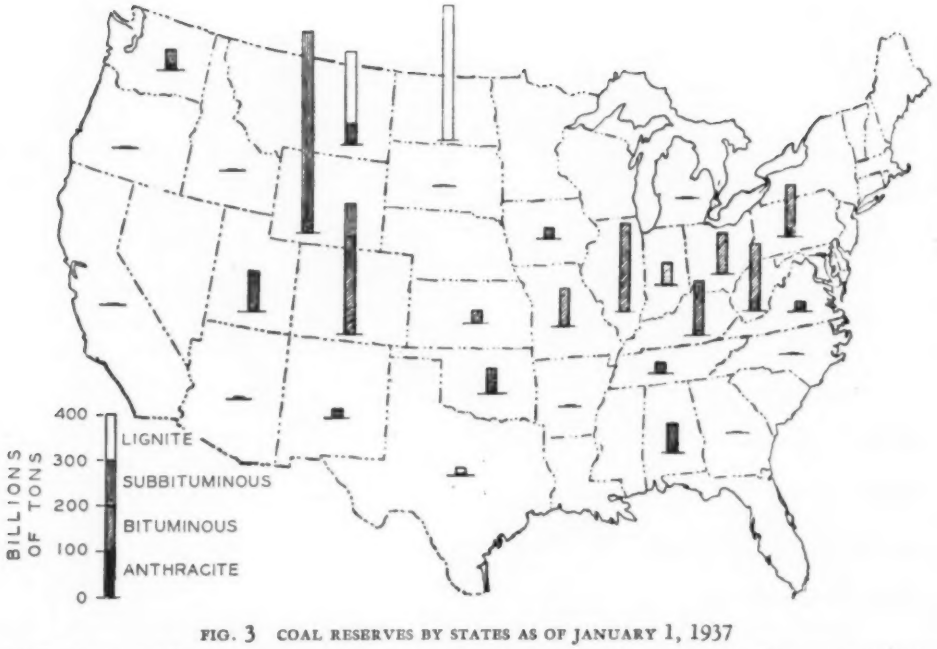

FIG. 3 COAL RESERVES BY STATES AS OF JANUARY 1, 1937

(Anthracite, subbituminous, and lignite reduced to bituminous-coal equivalent, according to "Energy Resources and National Policy.[3]")

The Pennsylvania column is largely bituminous coal with a little anthracite. All of the West Virginia coals are bituminous, including low-, medium-, and high-volatile bituminous coal. West Virginia has the greatest reserves of the best grade and highest rank of bituminous coal of any state in the Union. Pennsylvania comes next in line. Illinois has the greatest tonnage of bituminous coal but it is inferior in grade and rank to the Appalachian coals. The coals of Illinois, Iowa, Missouri, Kansas, western Kentucky, and Indiana are inferior to the Appalachian coals for the production of metallurgical coke and are but little used for this purpose. The Ohio coals grade between the Illinois and West Virginia coals.

On a Btu basis, Wyoming has the largest reserves. The Wyoming column is the tallest on the map. It represents 590 billion tons of subbituminous coal and 30 billion tons of bituminous coal; North Dakota is second with 600 billion tons of lignite; Colorado is third with 213 billion tons of bituminous coal and 104 billion tons of subbituminous coal; and Montana is fourth with 316 billion tons of lignite, 63 billion tons of subbituminous coal, and 3 billion tons of bituminous coal. These four states contain 51 per cent of the nation's energy reserves in the form of coal and lignite.

It is evident from this review of the fuel reserves of the United States that ample supplies of coal are available for the production of the necessary requirements of gaseous and liquid fuels when the natural gas and petroleum reserves approach exhaustion and need to be supplemented from other sources. Satisfactory fuel gases have been manufactured from coal or from coke and petroleum for many years. Processes and equipment for this purpose have been well developed and the costs are known. In recent years, in Germany in particular, processes have been developed and put into commercial operation for the manufacture of liquid fuel from coal and from lignite. It is quite reasonable therefore to assume that plenty of gaseous and liquid fuels will be available in the future for many years, probably a thousand years; and of course, for a much longer period if atomic energy can be harnessed economically for the generation of heat and power. The cost probably will be greater than the present cost of petroleum and natural gas, but future developments in the more efficient utilization of fuels should go far in offsetting the cost of conversion. This is the long-view picture. But how about the near view? What will be the effect of the increasing natural gas reserves and the declining rate of discovery of new petroleum fields?

TREND OF PETROLEUM RESERVES IN THE UNITED STATES

The trend of discovering additional reserves of petroleum in new fields has been downward since 1939. During the same period the annual production increased from 1.26 to 1.7 billion barrels. While the present proved reserves of 20.8 billion barrels are the largest ever established, they are only 12.5 per cent greater than the reserves of January 1, 1940. This approximate figure has been maintained by the upward revision of reserves of previously discovered fields. Such revisions are made up of extensions of pools as more wells are drilled and increased recovery obtained in drilling and refining by the application of improved technological methods. In 1945, 400 million barrels were discovered in new fields and 1700 million barrels were added to the proved reserves by the revision and extension of old fields. The total of 2100 million barrels was 23 per cent higher than the 1945 production of 1700 million barrels. The proved reserve is about 12 times the current rate of production. It is a serious question of whether this ratio of reserves to production can be maintained without greatly increased discovery and production costs. Higher production costs mean higher prices for gasoline and other petroleum products, which in turn will lead to a greater proportion of conversion of crude petroleum to the more valuable products, such as motor fuels and domestic heating oils, and it would lead to increasing importation of foreign petroleum from South America and the Persian Gulf region.

However, from the standpoint of national security, as well as sound business, it is not desirable to place too great a dependence upon foreign sources of petroleum. Recent wartime experience proved that overseas' supply of petroleum could be seriously interrupted, even from near-by sources such as South America and along our own coastal routes from Texas. Therefore, it seems essential that we develop our domestic sources of synthetic

liquid fuels to the point where they could be utilized in time of emergency and where they would place a ceiling on the price that could be charged on foreign oil.

SOURCES OF SYNTHETIC LIQUID FUELS

A broad survey of other sources of liquid fuels in the United States indicates that petroleum may be supplemented by: (1) Alcohols from the fermentation of vegetable matter; (2) conversion of natural gas by the gas-synthesis process; (3) distillation of oil shale; (4) liquefaction of coal or lignite by the high-pressure hydrogenation process; and (5) conversion of water gas from coal or lignite by the gas-synthesis process. Any or all of these supplementary sources may come into use as petroleum supplies decline to the point where these higher-cost synthetic products become commercially competitive with natural petroleum products.

Alcohol. Alcohol has been used satisfactorily as a constituent in blended motor fuels in many foreign countries. Its present cost is greater than petroleum gasoline. The place which alcohol will take in the provision of future motor fuels will depend largely on its cost in comparison with gasoline from oil shale, lignite, and coal.

Conversion of Natural Gas. Natural gas can be converted to carbon monoxide and hydrogen, which are the raw materials required for the production of liquid hydrocarbons by the gas-synthesis process. An improved process has been developed by American industry and a plant is to be installed and operated by Carthage Hydrocol, Inc., at Brownsville, Texas. It is reported that the plant capacity per day will be approximately 7000 barrels of gasoline and Diesel oil and that the over-all cost of the products will be competitive with the cost of petroleum products. The natural gas will be obtained from a near-by field at a very low cost.

It also has been announced that a similar commercial plant is to be installed in the Hugoton gas field of southwestern Kansas. With natural gas costing not more than 5 cents per 1000 cu ft, engineers of American petroleum companies have estimated the cost of the gasoline produced at figures ranging from 5 to 9 cents per gallon. Recent estimates tend toward the lower figure. It is evident that low-cost natural gas in fields remote from markets will be the first source of synthetic fuels to come into commercial use in the United States.

Operation of the commercial plants in Kansas and Texas should give reliable technical and cost data for further development of more natural-gas plants, and also for the longer-range problem of utilizing coal or lignite in the gas-synthesis process.

While the proved reserves of natural gas are somewhat larger than the proved petroleum reserves, in terms of weight or heating value, they are very much smaller than the solid-fuel reserves, and much of the natural gas will find a more profitable outlet than its conversion to liquid fuel at the expense of losing one half to two thirds of its heating value.

Oil Shale. The oil-shale deposits are estimated at 92 billion barrels of recoverable oil. This amount is sufficient to supply our requirements at the 1945 rate of consumption of 1.7 billion barrels of oil for about 50 years, or about 4 times as long as our present proved petroleum reserves. The greater part of the shale reserve is in western Colorado, southwestern Wyoming, and eastern Utah. The assay value of these shales varies from 15 to 60 gal of crude oil per ton of shale.

Present estimates of the over-all cost per barrel of producing crude shale oil in this country vary from $1.80 to $2.50. These are educated guesses at the best. No commercial operations on which reliable estimates can be based have yet been conducted on American shales. Oil shale may prove to be an important supplementary source of liquid fuel in the United States. It is a material that has no practical use at present. Its utilization for the production of liquid fuels would be a sound conservation measure.

Liquid Fuels from Coal. Liquid fuels may be obtained from all ranks of coal, from lignite to anthracite, by one or more of the following processes: (1) The carbonization of bituminous coal; (2) the hydrogenation of high-volatile bituminous coal, subbituminous coal, lignite, and coal tar and (3) liquid hydrocarbons by catalytic synthesis from water gas (carbon monoxide and hydrogen) by the Fischer-Tropsch process.

BY-PRODUCT LIGHT OIL AND TAR OBTAINED IN CARBONIZATION OF COAL

Light oil and tar are obtained as by-products in the manufacture of coal gas, and coke. These by-products can be used as liquid fuels. The heating value of coal tar averages about 16,500 Btu, as compared to 19,000 Btu per lb for petroleum. Much of this tar is used as a liquid fuel at steel plants. From 10 to 12 gal of tar and 3 gal of light oil suitable for motor fuel are obtained in the high-temperature carbonization of a ton of coal. Low-temperature carbonization of coal yields 20 to 35 gal of tar per ton of coal. Low-temperature tar is more like petroleum than is high-temperature tar. It contains hydrocarbons similar to those found in petroleum.

Neither high- nor low-temperature carbonization converts all of the coal to liquid fuel. The liquid fuel is a by-product, and it is not commercially feasible to maintain a liquid-fuel industry based upon a by-product. In a coke-oven plant the main product is coke; therefore the number of such plants cannot exceed the market available for coke, unless the coke can be used in a parallel plant for the production of carbon monoxide and hydrogen for conversion to liquid fuels. Fortunately, such a process is now available. It has been used in the production of synthetic ammonia from gas or coke. In a similar manner, gasification and coking plants can be linked with a synthetic-fuel industry by using the resulting gas and coke as well as the tar and light-oil by-products in the manufacture of synthetic liquid fuels. The Germans thus combined in various ways their existing gas-manufacture and coking plants with both the coal-hydrogenation and the gas-synthesis processes for the production of liquid fuels.

PROCESSES FOR DIRECT PRODUCTION OF SYNTHETIC LIQUID FUELS

There are two processes for the direct production of synthetic liquid fuels from coal or lignite. These are the coal-hydrogenation, or Bergius-I.G., process, and the gas-synthesis, or Fischer-Tropsch, process. Both processes were invented and developed in Germany and were in commercial use in Germany for several years before the beginning of the recent war. Liquid fuel is a primary product in both processes; combustible gases and solid waxes are obtained as by-products. There is no large residue of coke, such as is obtained in carbonization processes. Therefore hydrogenation or gas-synthesis plants can be installed for the principal objective of making liquid fuels.

The coal-hydrogenation process consists of forcing hydrogen into the complex coal molecules and removing oxygen so that their chemical constitution is changed to approximately that of petroleum, whereupon the coal substance liquefies. This reaction is accomplished by mixing approximately equal parts of finely pulverized coal or lignite and heavy oil previously obtained from the process, and pumping this paste into a high-pressure steel vessel together with hydrogen gas at pressures of 3000 to 10,000 psi. A small amount, about 0.1 per cent of the coal, of a catalytic material such as a compound of tin or iron oxide is added to speed up the reaction. The temperature of the reacting mass is maintained at 800 to 900 F.

The oil product from the reaction vessel is separated from the solid residue of ash-forming material and unliquefiable carbo-

naceous matter and is distilled into light-, middle-, and heavy-oil fractions. The light oil is refined directly to gasoline. The heavy oil is recycled for preparation of the coal-oil paste.

The middle oil from the liquid-phase stage is hydrogenated further by pumping it and hydrogen at about 3000 psi through a preheater into the "vapor-phase" converters. These converters are of the same dimensions as the liquid-phase converters, but they are filled with tungsten or molybdenum catalyst pellets.

The gas-synthesis process can use as raw material any coal, coke, lignite, natural gas, or other carbonaceous material. The coal or other fuel is first converted with the aid of steam to water gas, a mixture of carbon monoxide and hydrogen. This mixture of gases is in the proportion of 2 volumes or 1 volume of hydrogen to 1 volume of carbon monoxide and, after suitable purification, is then passed over a solid catalyst at relatively low pressures (1 to 10 atm) and temperatures ranging from 300 to 400 F. Under these conditions the gases combine to form oils and waxes.

Hydrogenation-process oils are high in naphthenes and aromatic hydrocarbons. The gasoline has a high octane value (up to 92 octane when treated with tetraethyl lead) and is suitable for aviation gasoline. Gas-synthesis-process oils are composed largely of paraffin hydrocarbons which have a low octane value. It can be reformed to about 70 octane number and thus is suitable for motor gasoline. However, this process produces an excellent Diesel oil of high cetane number.

Most of the high-volatile bituminous coals, the subbituminous coals, and the lignites of the United States are suitable for the hydrogenation process. Anthracite coals do not respond to hydrogenation, and progressively lower yields of liquid fuels are obtained, as the volatile matter of the coal decreases to medium-volatile and low-volatile rank. The ash of the coal should be as low as possible, and preferably under 4 per cent. Fortunately, this requirement can be met with many coals because only one half of the total coal used goes into the liquefiers. This consists of the low-ash portion of the coal, which is separated in a special washing process. The higher ash remainder is burned under the boilers for production of process steam and power used in the plant.

From a conservation point of view, it is fortunate that low- and medium-volatile bituminous coals are not suitable for hydrogenation. On the basis of energy content, these coals comprise only 3 per cent of our total coal reserves. They are needed for the production of metallurgical coke for the steel industry and for supplying semismokeless domestic fuel. The large reserves of high-oxygen, poorly coking coals of Ohio, Indiana, Western Kentucky, and Illinois, and those high-volatile bituminous coals which are not excessively high in ash or sulphur west of the Mississippi River are available and potentially suitable for the production of liquid fuels by the hydrogenation process.

The subbituminous coals of Wyoming, Colorado, and Montana and the lignites of the Dakotas, Montana, and Texas, are readily liquefied, and from the point of view of wise utilization of mineral resources, constitute appropriate raw materials for synthetic liquid fuels. These coals slack and break down into small pieces on exposure to air. Therefore they do not stand transportation to any great distance from the mines nor can they be stored safely for long periods without some precautions that will retard this weathering process. Conversion of these coals to liquids would solve the storage and transportation problems.

In the assay work thus far conducted in the Bureau of Mines laboratories, liquefaction proceeds most readily in coals of more recent geological age than carboniferous. Approximately 0.6 ton of high-grade bituminous coal is required for the production of 1 barrel of gasoline. Progressively larger amounts of coal are required as the rank of the coal decreases. For subbituminous coal, the requirement is 0.9 ton and for lignite 1.2 tons.

The gas-synthesis or Fischer-Tropsch process has a much wider application to more diverse raw materials than does the hydrogenation process. Almost any carbonaceous material can be reacted with steam to produce carbon monoxide and hydrogen, which in turn are reacted with each other in their conversion to liquid hydrocarbons. Raw materials that have been used for this purpose include anthracite, all ranks of bituminous coal, coke, lignite, coal gas, natural gas, charcoal, wood, and other vegetable matter. The German plants used coke from bituminous coal in the Ruhr district and brown-coal briquets or brown-coal char in central Germany.

In the Appalachian region, the necessary synthesis gas can be produced from the lower grades of anthracite that do not find a ready market at the present time, and from high-volatile bituminous coals unsuitable for metallurgical coke.

The Interior Province on both sides of the Missisippi River, with its very large reserve of poorly coking coals and its large population, is in a favorable position for the development of a synthetic-liquid-fuel industry. However, the largest reserves of solid fuels that seem to have the most promise for future conversion to liquid fuels are the lignitic and subbituminous coals of the Dakotas, Texas, and western Great Plains states. North Dakota alone has a reserve of 600 billion tons of lignite, and Wyoming has 590 billion tons of subbituminous coal. Some of these coals occur in very thick (20- to 50-ft) beds, and in one operation in Wyoming a total thickness of 80 ft is mined in an open strip pit. Strip mining under such conditions is very inexpensive. It may be able to contribute enough saving in the cost of raw materials to compensate for the lower yields of liquids obtainable from these low-rank fuels. Transportation costs of the liquid product to centers of consumption is, of course, a handicap for plants in these fields. However, this problem will be no greater than it has been in the development of the great Mid-continent petroleum industry.

COST CONSIDERATIONS

While much information has been obtained by the American technical oil mission to Germany, the data on costs require much more detailed examination than has yet been accomplished. The cost estimates from Germany vary greatly in different plants and reflect hasty development and construction to meet war needs. From these reports thus far examined and from British and American industry estimates, it appears that, in general, the cost of producing gasoline from solid fuels in this country by the hydrogenation process would be about 10 to 15 cents a gallon more than the cost of production from petroleum. With future improvements in the Fischer-Tropsch process that are likely to develop as a result of research, it is regarded as quite possible that gasoline and Diesel fuel will ultimately be produced at a cost of only 6 to 8 cents more than the present cost of production from petroleum. Some authorities believe that this cost will be less than that of mining and processing oil shale. The Bureau of Mines, in its synthetic-liquid-fuel program, is making no assumptions on costs at present, but is including oil shale and both synthetic-fuels processes in its experimental investigation on methods and costs.

CONCLUSION

In conclusion, the presently proved fuel reserves of the United States, solid, liquid, and gaseous, may be summarized as amounting to the energy equivalent of 2.6 trillion tons of bituminous coal having a heating value of 13,000 Btu per lb. Coal and lignite comprise 98.8 per cent of this energy reserve; 55 per cent of this solid-fuel reserve consisting of high-volatile bi-

(*Continued on page 228*)

Methods of ACCIDENT CONTROL *for* ENGINEERS

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THERE is much to be said in favor of planning action before the action is taken. There is sound defense also for acquiring a factual background knowledge of the matter to be dealt with, including data on need and value, reasons for the existence of the problem and the responsibility of individuals for solving it. However, when need, value, and responsibility have already been recognized, when persons are eager to act, certain they have the facts, but are impatient of the delay created by further instruction and planning, one of the very best methods of getting results is to forego the usual orderly approach and launch an immediate attack on the final and major phases of the problem itself, knowing that such a direct approach must of necessity expose and deal with any existing deficiency of knowledge. That is the objective of this discussion of practical methods of controlling accident occurrence available to the engineer. The need and value of accident prevention have already been established. Proper attitudes and abilities may be taken for granted. So, too, may be the factual knowledge of specific personal and mechanical accident causes. The elimination or correction of these causes and, especially, their prevention in the first place, remain as the subjects to be dealt with.

FOUR BASIC METHODS OF CONTROL[2]

Basically there are four methods or fields of activity in controlling the occurrence of accidents and of production faults. These are as follows:

1 Engineering revision (broadly defined)
2 Instruction, persuasion, and appeal to motivating characteristics
3 Personnel adjustment
4 Discipline.

Logically, the remedy for the occurrence of accidents is to eliminate the direct and proximate causes. These causes are variously estimated to be from 50 to 88 per cent personal, thus indicating that most use should be made of basic methods 2, 3, and 4, which require an educational or other personal approach. However, in practice, basic method 1, "engineering revision," is often found to provide a practicable remedy. In fact, it should invariably receive first consideration whether the accident causes be personal or mechanical.

It may be said that safety begins with a clean, orderly, and nonhazardous environment; also that industrial operations should be made as nearly foolproof as possible. As an example, consider the task of lubricating line and countershafting where safe practice calls for the careful use of a long-spout oil can. The oiler who violates the safe-practice rule may be injured. In that case the accident can be charged properly to a personal cause, indicating a choice of personal remedies 2, 3, or 4. These remedies indeed are effective but how much more immediate, certain, and satisfactory would be the provision of a remote-control manifold type of lubrication, coupled with an enclosure or guard for the shafting. Stated in another way, although the ratio of personal to mechanical accident causes may be 8 or 9 to 1, the ratio of personal to mechanical control methods of the most practical nature is close to 1 to 1.

Engineering Revision. Engineers are accustomed to deal with facts and, although their training qualifies them to solve problems on the basis of intangibles, it is perhaps not farfetched to conclude that they do their best work in the factual field of design and construction involving tools, equipment, processes, and procedures where reliance is placed upon the engineering sciences. Thus engineering revision, the first and most important control method in accident prevention, is typically a task for the engineer. He should bear in mind, however, that the human element must always be considered. This means that he should know what unsafe practices have already been associated with the device or the operation he deals with; also, he should have sufficient background of knowledge and enough imagination to provide against other unsafe practices that are likely to occur.

This field of preventive activity is so comprehensive that it is an advantage to describe briefly its cardinal subdivisions as follows:

(*a*) Eliminating at the source
(*b*) Guarding
(*c*) Revising
(*d*) Relocating.

Eliminating a hazard at its source differs from the other three forms of corrective action chiefly because, in lieu of guarding, etc., the hazard itself is done away with completely as, for example, when a noninflammable cleaning solvent replaces gasoline or naphtha.

Guarding refers to the many forms of enclosing, barricading, or installing safety devices for the point of operation of dangerous tools and machinery, for walk and work spaces and dangerous moving parts, and physical conditions in general. It applies to persons as well as to machines as, for example, when gloves, goggles, masks, etc., are worn. Incidentally, it would be well for engineers to know that there are at least six basically different kinds of devices or methods of guarding machines, and that it is indeed a rare case when one of these methods does not apply.[3]

Revising means altering or changing about, as when cleats or indented hand grips are placed on tote boxes in order to provide safe room for the fingers, or when power hoisting is done instead of manual lifting of heavy and cumbersome objects.

Relocating is the work of moving a piece of hazardous equip-

[1] Assistant Superintendent, Engineering and Inspection Division.
[2] "Basics of Supervision," Alfred Best & Co., Inc., New York, N. Y., 1944.

Contributed by the Safety Committee and presented at the Annual Meeting, New York, N. Y., December 2–6, 1946, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[3] "Industrial Accident Prevention," by H. W. Heinrich, McGraw-Hill Book Company, Inc., New York, N. Y., 1941.

ment from one place to another that is less likely to cause accidents, as when a drive motor or floor shafting is placed well overhead and out of reach or when a sandblast unit is taken from within a building and placed outside.

Instruction, Persuasion, and Appeal. An engineer whose work is strictly technical may have limited opportunity to apply the method of instructing, persuading, etc., but many engineers are also executives or supervisors and to them this method is equally as valuable as engineering revision.

Although the name of this method is largely self-explanatory, it should be explained that "instruction" is best applied by the generally accepted four-step plan of telling, demonstrating, practice by the instructee, plus check and follow through.

Persuasion and appeal, a method also available to the engineer-supervisor, gets best results when based upon the motivating characteristics of the person appealed to. These characteristics, as pride, loyalty, conformity, fear, etc., can readily be determined

Personnel Adjustment. When both engineering revision and instruction, persuasion and appeal, do not provide a workable solution, it is often because employees are physically or mentally unsuited to the job. Correction in such cases is obviously not a task for an engineer, rather it belongs to the physician or the psychiatrist, but the engineer-supervisor is in an excellent position to take the first step. He can and should note failure to perform safely and then, by observation, inquiry, and deduction, decide that the person in question is not normal and see to it that he receives attention from authorized medical practitioners.

Discipline. Too often is this valuable method ignored. Probably such disregard is due to its delicate and controversial nature or because it is considered only from the penalty angle. More correctly, to discipline means to "accustom a person to proper, safe, orderly, or systematic performance." Even penalty forms of discipline may be mild as when a person is admonished but not fined or "laid off," or when freely granted special privileges are withheld until he reforms. In any event, under any and all circumstances, there must be discipline in any well-ordered and successful industrial establishment; when the engineer is responsible he should see that it exists.

Selection of Method. Here is a point that the logical mind of the engineer will grasp immediately. When more than one method of solving an accident problem is available, the one most likely to succeed quickly, easily, and inexpensively should be selected. Four methods are available. As stated, engineering revision, as a practical matter should always be considered first but, before applying it or any other arbitrarily selected method, it is wise to give thought to the other three. This is especially important when the problem is a recurring one and the selected remedy has already been tried and has failed.

Fortunately, the right method or remedy can readily be determined by finding the reasons the problem exists in the first place.

REASONS FOR PERSONAL OR MECHANICAL ACCIDENT HAZARDS

1 Lack of information or knowledge
2 Lack of conviction as to safe practice
3 Force of habit
4 Difficulty, embarrassment, inconvenience, etc.
5 Improper attitudes
6 Physical unfitness
7 Time and cost.

An example will serve to demonstrate the value of considering the foregoing "reasons" before applying an arbitrarily selected remedy for accident occurrence.

Three departments in a warehouse had a high accident frequency caused by the same specific unsafe act of fork-lift operators. In each case the operators cut corners so sharply as to knock down stacked cases and cause injuries. After several unsuccessful attempts to cure the situation by means of instruction, it was discovered that several of the operators in one department had poor vision, another group had good vision but were reckless, and the third group had both good vision and the proper attitude but had not realized that the practice was especially dangerous, even though minor injuries had occurred, Obviously, it would do no good to put glasses on group three to keep on instructing group two, or to admonish the first group that had poor vision. The remedy for a given situation should suit the reason for its existence.

Accident prevention calls for science, thinking things through, the determination of facts, analysis, conclusions based on facts, knowledge of machines, tools, and operations, all of which are features of the engineer's training and experience. Sales ability and personality of course are also requirements and the engineer, in the author's opinion, qualifies in these respects as well as the others. He will succeed best, however, if he appreciates the fact that several methods of prevention and correction of personal and mechanical hazards as here discussed, are available, when he clearly understands them and knows how to make them effective.

The National Fuel Reserves

(*Continued from page 226*)

tuminous coal, 23 per cent subbituminous coal, 19 per cent lignite, 2.5 per cent low-volatile bituminous coal, and 0.5 per cent anthracite. The highest-rank and the highest-grade coals, amounting to about $^1/_6$ of our total tonnage of coal and lignite, occur in the eastern and Appalachian states, where industry and population are more concentrated. Another $^1/_6$ occurs in the central states on both sides of the Mississippi River. This coal is of lower rank, and much of it is of lower grade, but it is all of high-volatile bituminous rank, although less strongly coking than the eastern coals. Of the remaining two thirds of our solid-fuel reserves, 80 per cent consists of subbituminous coal and lignite in the Dakotas, Montana, Wyoming, Colorado, and Texas. All of these fuels can be converted by suitable processes to gaseous and liquid fuels. Some are operating commercial processes that have been used for many years in the gas- and coke-manufacturing industries. These are applicable to the coking coals of the eastern and central states.

No processes are operating commercially in this country for the production of fuel gases from the low-rank noncoking coals that predominate in the western states. However, such processes have been developed and were in commercial operation before and during the war in Germany. It is probable that these methods can be modified for the gasification of American lignite and subbituminous coal, and it is possible also that new methods may result from American research now in progress in several organizations.

The Bureau of Mines has developed an annular metal-alloy retort which is now in pilot-plant operation at Grand Forks, N. Dak. A gas of high hydrogen content having a total heat of combustion of about 310 Btu per cu ft is obtained. Other investigators are working on the gasification of these low-rank fuels in fluidized or pulverized form. It is reasonable to assume that in a few years more efficient and more practical methods will be developed than those now available for these noncaking fuels. With such developments, all reserves of solid fuels can be used to supplement declining reserves of natural gas and petroleum for many years, certainly not less than 1000 years and probably for 2000 years.

THE WANING OF INFLATION[1]

By RALPH E. FREEMAN

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THE American economy has reached a critical stage in its postwar development. It has experienced an inflationary movement that has lifted prices considerably above the level prevailing at the end of the war. But now the pressure of inflation is waning. Price weakness has already appeared in food, textiles, and other so-called "soft goods." Does this mean a reversal of trend? Are we at the beginning of a decline in the general price level, a deflation that will lead to slump in general business activity?

During the last few years three forces have been operating to raise the price level: (1) There have been shortages of goods available for purchase by consumers—attributable to the diversion of labor and other resources into war production. (2) There has been an excess supply of purchasing power in the form of currency and bank deposits, created by the sale of huge quantities of government bonds to the commercial banks. (3) Wages have been increased, thus raising costs and adding to the inflationary pressure.

In recent months these forces have been diminishing. Reconversion has been virtually completed and industries are turning out goods in increasing volume. The government is no longer selling bonds to the banks. In fact, the Treasury has retired nearly $20 billion of its short-term debt, thus reducing the total of bank deposits. And, finally, the wage demands of organized labor seem to have moderated considerably.

Economists are not unanimous on the question of the future of prices. Some believe that we are headed for deflation and a severe business recession. They assert that prices have risen so far and so fast that a reaction is inevitable. Prices have outrun ability to buy. They point to the fact that since the end of the war the cost of living has risen faster than "disposable" income. And in support of their position they refer to current markdowns in the prices of many articles of food and clothing. They see this price decline spreading to other consumers' goods and bringing on a collapse of the whole price structure.

Another group of economists believe that the influences sustaining prices are strong enough to prevent a general collapse. One such influence is the tremendous carry-over of wartime savings in the form of currency, bank deposits, and government bonds. Over $100 billion of these liquid assets are in consumers' hands. Another supporting factor is the deferred demand for durable goods of all kinds—consumer durables such as automobiles and houses, as well as industrial plant and equipment.

This more optimistic group believes that the statistical changes in income and in cost of living are deceptive. The apparent lag between the two series is being offset by three factors: (1) The use of the liquid assets already mentioned; (2) the expansion of consumer credit now proceeding apace; (3) the fact that people are spending a larger proportion of their disposable income, that is, saving less.

If economists are divided on this issue, it is no wonder that the layman is confused. There is as yet no clear and definite trend observable. There is price weakness in some lines and if bumper crops materialize this year, the prices of farm products are likely to tumble. On the other hand, many prices are firm and some further isolated advances will doubtless be witnessed in coming months. Labor may yet upset the applecart and initiate another twist in the wage-price spiral.

It appears to the writer that the forces of inflation and deflation are now approximately in balance. This does not mean that individual prices are in proper relation to each other. Because some have risen much more than others, a good deal of readjustment among particular items and groups of prices is to be expected. In fact, one of the dangers of the present situation is that such readjustments may be so severe and so synchronized as to precipitate a cumulative deflation.

If this unfortunate combination of events fails to unstabilize the system, I am inclined to think that the economy will be able to shift gears without a prolonged slowdown. The passing of inflation will be followed by a period of relative stability. It is true that such a pattern of change is at variance with that which followed World War I. But economic conditions today are in many important respects different from what they were then. Perhaps the main reason for confidence in the maintenance of a high level of production and employment during 1947, is the outlook for durable goods. With industries producing steel, buildings, automobiles, industrial equipment, and the like, running at high speed—and most people seem to agree that such will be the case—it is hard to see how the economy as a whole can experience a severe or prolonged setback.

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

IT is not only the intellect that can be developed by scientific life, however, but the will as well. Science imposes a discipline that can leave as strong a mark on the character as can its stimulation on the intellect. Science, like all intellectual work, demands (to quote von Hugel) "courage, patience, perseverance, candor, simplicity, self-oblivion, continuous generosity toward others, willing correction of even one's most cherished views."[2] Again, like all learning, science demands a twofold attention, to brute facts and to the synthetic interpretation of them; and so it forbids a man to sink into himself and his selfish claims and shifts the center of interest from himself to outside. But for scientists there is a special and peculiar discipline. Matter is perverse and difficult to make behave as one wants; the technique of experimental investigation is a hard and chastening battle. Nature seems not to care whether we can understand her or not; she hides her secrets, and her facts are great slayers of theories. It is in this contact with "brute fact and iron law" that von Hugel found the basis of a modern and scientific asceticism, and in submission to this discipline that he found the detaching, desubjectifying force that he believed so necessary to the good life.

Science, then, can help to stimulate the intellect and to discipline the will. To this extent it has bearings on the good life. But it cannot do this work alone: it must take its proper place in a liberal education and an open culture. The right use of science as a school of rational life depends on its being set in a matrix of other studies and other activities. Science by itself throws no light on its own value, nor on values in general. It is not a royal road to knowledge of every kind.—From "The Values of Science," by E. F. Caldin, *Endeavor*, vol. 5, No. 20, October, 1946, pages 162 and 163.

[2] *Mystical Element of Religion*, ii, p. 349.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Spaceships

A PAPER entitled "The Challenge of the Spaceship," which A. C. Clarke read to the British Interplanetary Society in London, England, and which appeared in the December, 1946, issue of the *Journal* of that society, included some interesting prophecies and forecasts concerning the research activities and the future possibilities regarding interplanetary travel by rockets, guided missiles, and atomic-powered spaceships. The following remarks, slightly abridged, are quoted from Mr. Clarke's address:

Every major country in the world is conducting rocket research, or will soon be doing so. The British Government is setting up a 1000-mile-long range in Central Australia; every week the Americans are firing off V2's loaded to the scuppers with cosmic-ray telescopes, Geiger counters, and anything else that occurs to them. When the war ended, the most advanced rocket project was the German A9-A10 combination, with a range of 3000 miles, a pay load of 1 ton, and a top speed of 8000 mph—a third of the velocity needed to escape from earth. There is no doubt whatsoever that smaller radio-controlled rockets capable of reaching the moon can be built with the techniques that exist today, though the design of man-carrying machines capable of making a safe landing and returning to earth is immensely more difficult.

The first guided missile to reach the moon will probably crash into it around 1950. The public, not realizing the problems still to be faced, will expect human beings to follow in a very short time. It will be disappointed. During the subsequent years there will be innumerable short-range flights beyond the atmosphere by man-carrying ships reaching heights of a few thousand miles, but if we have to rely on chemical fuels, it may well require at least twenty years of further experimenting before the first true spaceship lands upon the moon and returns to earth.

That brings us up to the 1970's. Any chemically-fueled spaceships will be unwieldy fabulously expensive beasts with fuel consumptions measured by the thousand tons for a single voyage. Only a few countries will be able to build them and they will be of scientific value only. There will be no question, for a long time, of colonization or voyages to the other planets. But—and it is a very large but—any prophet would indeed be rash if he based his predictions upon the use of chemical fuels alone.

Here, as in other fields, the great question mark is atomic energy. In theory, a few pounds of uranium could take a ship weighing many tons to the moon and back. In practice, we have not the faintest idea how this could be done. It seems possible that some form of enriched high-temperature pile could be developed to accelerate a working fluid such as hydrogen, helium, or some other gas of low molecular weight and so give a propulsive jet. The solution may be very simple. It may come at any time—it may have come already.

The application of atomic energy to aircraft propulsion is an exceedingly difficult problem, but it is the one which will pay the greatest dividends. The cost of the fuel is only a small part of the price of electric energy, and we can easily do without atomic power stations for a good many years to come. But an atomic airplane, capable of unlimited ranges, would be quite another proposition and would revolutionize air transport. Even if the plant and its shielding weighed fifty tons (and there were only six tons of metal in the first Chicago pile) the price would still be worth it to obtain a built-in fuel supply for very large aircraft.

There is no doubt that those concerned fully realize this fact, and we may expect intensive and highly unadvertised research into atomic propulsion for aircraft and rockets. In the United States, it has already been announced that the Fairchild concern has received a government contract for such an investigation.

The race is already under way. Possibly, a little radio-controlled chemical rocket, with a pay load of only a few pounds, will be the first to reach the moon. The giant chemically powered spaceship may never be developed—just as the steam-driven airplane was never built, though it might well have been had the petrol engine not come when it did.

Atomic power is hardly likely to advance the conquest of space by more than ten years, but it may make it a really practical proposition almost from the beginning, which otherwise would certainly not have been the case. What is equally important, it will mean that the whole solar system, and not merely the moon, will be immediately accessible to man. It requires relatively little power to reach the other planets if the journey begins from the moon, but the most economical voyages involve months or even years of "coasting" along orbits curving halfway round the sun. With atomic power these journeys could be cut to a fraction of the time. For example, the "cheapest" journey to Mars—as far as fuel is concerned—lasts 258 days. With an atomic ship, traveling by a more direct route at quite a moderate speed, it need take only two or three weeks.

Education

AN old institution at Wright Field, Dayton, Ohio, the old Air Force Engineering School, has been expanded and renamed the Army Air Forces Institute of Technology, according to the January, 1947, issue of *The Pegasus*.

This institution has been designed not only to solve the AAF's problem of providing for itself a reservoir of trained technical personnel, but also to offer a future to officers whose education at the outbreak of war was interrupted, or whose careers had just begun. The reasons for an AAF Institute of Technology arose as the result of the scientific advancements made during World War II, which led to the conclusion that military operations of the future will be won by the nation at whose command are the most highly scientific developments.

There are now 190 Army Air Forces officers enrolled in the

AAF Institute of Technology. The ages of these men range from 22 to 45 years, with military ranks from 2nd lieutenant to full colonel. The previous experience of the students is varied, including all types of Army Air Forces and civilian occupation specialties.

The field of instruction of the Army Air Forces Institute of Technology is divided into broad groups, namely, engineering and business. (The business phases of instruction are designed to provide academic instruction pertaining to the various logistical phases of Army Air Forces activities.) All of the individual courses are conducted on the level of a junior-senior-year college curriculum. For officer-students possessing the necessary academic prerequisites, enrollment is accomplished in a one-year course consisting of three semesters of four months each. All members of the present one-year class already possess college degrees. Officers meeting the minimum academic qualifications of the Institute are enrolled in a two-year curriculum consisting of six semesters of four months each.

The engineering curriculum is composed of courses in mathematics, including advanced calculus, differential equations, operational calculus, functions of the complex variable, physics, engineering mechanics, aerodynamics and airplane design, thermodynamics, aircraft-propulsion systems and power-plant design, strength of materials, materials of construction and aircraft structures, electronics, nuclear physics, servomechanisms, and other scientific subjects.

The business course of instruction includes certain basic courses in engineering, such as mathematics, mechanics, and aerodynamics, together with work in production and industrial management, economics, accounting, business organization, personnel management, economic geography, industrial planning, marketing, and purchasing.

The graduate of the engineering phase of the Institute's work will be enrolled either in graduate study at civilian universities or assigned to duty in the various engineering laboratories of the Air Materiél Command. Students completing the business curriculum will assume positions in the vast industrial organizations of the Air Materiél Command (procurement, production, inspection, supply, etc.) or continue formal education in one of the leading graduate schools of business.

Specifically, the Institute will provide training which will assure proper scientific research, design, and technical development of Army Air Forces equipment and the efficient execution of procurement, supply, production, and planning responsibilities assigned to the AAF.

Postgraduate work is also offered in the social sciences as well as the natural sciences, with such institutions as Stanford University, Massachusetts Institute of Technology, Harvard, California Institute of Technology, Columbia, and the University of Chicago participating in the program.

The fields of study include all phases of aeronautical engineering, chemistry, physics, electronics, civil and mechanical engineering, business administration, production management, geopolitics, law, psychology, personnel management, and many other standard subjects.

Aluminum Fabrics

THE December, 1946, *Aluminum Bulletin* reveals that women's fashions of tomorrow will be spun from aluminum yarn. It is said that this will be made possible by "Lurex," a new metallic fiber, which has recently been introduced in the textile world. The product is a co-operative development of Dobeckmun, Eastman Kodak Company, and Aluminum Company of America.

Although the material is the first to be manufactured from aluminum and acetate, aluminum yarn is far from new. The Reynolds Metals Company has had a yarn on the market for some five years which has been in heavy demand, particularly by makers of evening wear. The Reynolds product is constructed by cutting foil into thin strips which are formed on to the desired fibers to produce a thread which may be put directly on the loom. Unusual patterns from this yarn have been worked out by some of the country's leading designers.

Essentially, Lurex consists of 0.00045-in-gage aluminum foil, bright on both sides, slit, and coated with acetate. The yarn is impervious to tarnish, much lighter than ordinary metallic yarns, and easy for textile workers to handle. Combined with wool, rayon, silk, cotton, and other materials, it is spun into plain and fancy fabrics used in the manufacture of evening gowns, bathing suits, shoes, millinery, coats, draperies, and upholstered fabrics. Designers see unlimited future applications in all manner of clothing and accessories.

The new fabric offers the textile trade a number of advantages. It possesses remarkable elongation characteristics which make it readily adaptable to modern weaving equipment and techniques. Tests conducted by Dobeckmun and leading textile mills have proved that it is nonabrasive with other fibers. Reports indicate that it cannot tarnish. Just to prove its durability, samples have been soaked in hydrogen sulphide for 24 hours, dipped into sea water and dried repeatedly, immersed in 90-proof gin, and run through the gamut of rough handling. The hydrogen-sulphide gas tests, incidentally, were conceived to duplicate the tarnishing effects of years of normal use.

The metallic yarn is now produced in gold, silver, and copper, and can be woven by itself, or combined with numerous fabrics. Later, it will also be marketed in brilliantly irridescent colors. Color effects are produced by adding pigment to the adhesive which permanently bonds the plastic film to both sides of the metallic base. Since the color is protected by the transparent acetate film, it cannot flake off or deteriorate.

Illumination Intensity

AN attempt is made by A. A. Kruithof and H. Zijl in their article "Illumination Intensity in Offices and Homes," appearing in *Philips Technical Review*, August, 1946, to solve the problem of the most suitable illumination intensity for the activities of office and home.

In every human activity the task of the eye comes down to distinguishing some detail against a given background under the given illumination intensity. In reading printed matter the details are formed by the printed letters, in drawing by the penciled line, in sewing by the peculiarities of the weave of the material, while in the first two cases the background is a sheet of paper and in the third it is the material as a whole. The requirements made upon the eye in the different activities can be characterized by the following quantities: (1) the angle of vision; (2) the contrast; (3) the time of observation; and (4) the length of time during which the activity is continuously performed.

Each of the first three quantities must exceed a certain (minimum) value (depending on the other circumstances) in order to make an observation possible.

The threshold values depend very much upon the intensity of illumination. A consideration of this relation will furnish us with a first indication about the desired illumination levels. Meanwhile, the effect of the other characteristics of the illumination will become evident such as the color and distribution of the light, and especially the brightness of the surroundings, for instance, the walls of the room.

In Fig. 1 the visual acuity S_a of an average observer is shown

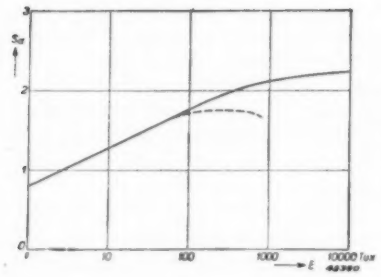


FIG. 1 VISUAL ACUITY S_a OF AN AVERAGE OBSERVER AS A FUNCTION OF THE ILLUMINATION INTENSITY E OF THE BACKGROUND

as a function of illumination intensity. It may be seen that up to about 1000 lux visual acuity increases rapidly, while above 1000 lux it increases only slowly. (One lux is equal to one lumen per square meter, or 0.0929 foot-candles.) The broken-line curve shows how the performance of the eye decreases when the brightness of the surroundings is too low.

In Fig. 2 analogous curves are drawn for the contrast sensitivity S_c. First consider curve 1, which is the most important. Here also a rapid increase in the performance of the eye is observed when the illumination intensity is increased to the region of 1000 lux, while at still higher illumination intensities the increase becomes very slight. Curves 2 and 3 prove again the harmful influence of too-dark as well as too-bright surroundings; in the latter case this is a consequence of glare. Curve 4 is recorded with a larger test object than the others; the contrast sensitivity in this case is higher over the whole range.

Similar behavior as for visual acuity and contrast sensitivity is found for the speed of observation, but here the increase with illumination intensity is only worth while up to 100 lux, above which it is only slight.

The last point on the list is the duration. The effect of the duration manifests itself in the fatigue phenomena. It is remarkable that this fatigue is scarcely manifested in the performance of the eye as far as visual acuity and contrast sensitivity are concerned. The performance of an activity considered as a whole, however, is felt to be "more difficult." Parallel with certain physiological phenomena, such as more frequent blinking and a slowing up of the heartbeat, a general decline in the performance of the work is observed, a decrease in the rate of reading, in the accuracy of drawing, and the like.

FATIGUE TESTS

The increase in the performance of the eye with increasing illumination intensity may be related to the fact that with increasing illumination intensity observation becomes "easier." From the shape of curves of Figs. 1 and 2, it is possible to some extent to read off the degree of this increase in ease. The fact that an increase in illumination intensity makes observation easier, while we have just ascertained that upon long duration of the activity observation of work becomes more difficult, makes it reasonable to expect that illumination intensity will have an effect on the occurrence of fatigue. It is, however, obvious that it will not be so simple to determine this effect quantitatively as the effect on the observation thresholds, on account of the difficulty of expressing in numbers the effect of becoming fatigued.

Direct tests of fatigue have been made by M. Luckiesh and F. K. Moss, among others. Fatigue occurring upon reading under accurately determined optical conditions which may be considered as an idealization of the conditions occurring in practice were investigated. Various criteria of fatigue were used. The most obvious is the decline in reading speed. Remarkably enough, however, this decline is always found to be only slight and consequently to exhibit only small differences for very divergent illumination intensities. This may be understood to mean that under worse visual conditions the eyes are stimulated by the brain to correspondingly greater effort. The relation between fatigue and speed of reading is thus lost for the greater part, so that speed of reading is not a very suitable criterion of fatigue.

Another criterion used in tests is the frequency of involuntary blinking during reading. This criterion is less directly connected with the act of reading than the speed of reading; but there appears to be a satisfactory correlation between greater difficulty in reading and more rapid blinking. Measurement of the number of blinks per unit of time at the beginning of reading and after one hour of reading gave the following results: at 10 lux an increase after one hour of 72 per cent; at 100 lux an increase after one hour of 31 per cent; at 1000 lux an increase after one hour of 8 per cent.

These results agree with the conclusions from Figs. 1 and 2 about the increasing ease of observation and it may therefore be accepted that an increase in illumination intensity from about 10 lux to 100 lux is accompanied by a considerable improvement of fatigue, while an increase from 100 to 1000 lux is still accompanied by an appreciable improvement. Above 1000 lux no direct fatigue tests have been carried out, but on the basis of the parallelism already mentioned a slight improvement similar to the curves of Figs. 1 and 2 may be expected.

It must further be mentioned that the influence of the brightness of the surroundings (at an illumination intensity of 135 lux) and of the spectral composition of the light was also studied. Equal brightness of surroundings and background were found to be most favorable. Incandescent lamps and luminescent lamps of daylight color gave no appreciable difference in ease of reading.

ILLUMINATION IN PRACTICE

The high levels of illumination found to be so favorable for the eye will seldom be found in offices and never in a living room. The reason for this is the influence of a combination of other factors besides the behavior of the eye.

For office illumination the utility factor is most important. Both for the initial installation and for possible alterations, it is primarily the economic advantages and disadvantages that are weighed.

What are the advantages? According to the foregoing an increase in illumination intensity will result in an increase in the production of the employees, which represents a certain money value. This increase will be considerable at low levels of illumination but will become less and less at higher levels, until finally there is no advantage at all. We thus obtain a variation of the advantages as indicated qualitatively by the continuous-line curve in Fig. 3. The region of illumination intensities where the curve is practically horizontal will lie higher according as the work performed in the office is more difficult.

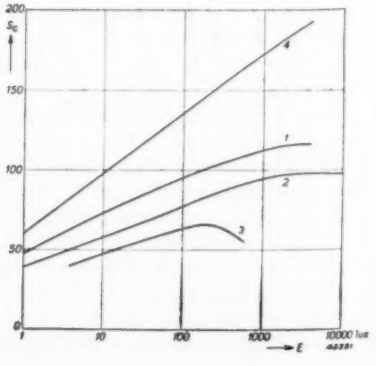


FIG. 2 CONTRAST SENSITIVITY S_c AS A FUNCTION OF THE ILLUMINATION INTENSITY OF THE BACKGROUND

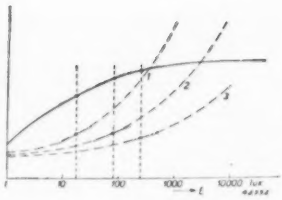


FIG. 3 SCHEMATIC VARIATION OF ADVANTAGES OF AN OFFICE ILLUMINATION (FULL-LINE CURVE) AND OF COSTS (BROKEN-LINE CURVES) AS A FUNCTION OF THE ILLUMINATION INTENSITY

Costs show an opposite trend. The additional expense entailed, for example, by doubling the illumination intensity is less at a low level of illumination than at a high level. The curvature of curve 1 in Fig. 3, which shows qualitatively the variation of costs, is thus just the opposite of that of the continuous-line curve representing the ensuing advantages. If the two curves are compared in two points pertaining to a given value of the illumination a certain value of the illumination intensity is found where the tangents are parallel. This is the point where the best economy is attained, because at a still higher illumination level the increase of expense is greater than that of advantages.

Due to advances in technique, in the course of time the curve of costs will fall with respect to the curve of advantages. The points showing parallel tangents will therefore be shifted toward the right, i.e., the most economical illumination level rises. Some indication of the height of that level at the present stage of technical development may be found in the values which are recommended by the lighting societies in various countries. See Table 1. The afore-mentioned advance in technique is clearly manifested in United States values for different periods.

TABLE 1

	U.S.A.			Great Britain	Switzerland before
Type of work	1930	1939	1942	1937	1940
Reading and writing with interruptions	80–100	200	250	100–150	150
Long-continued calculation or study	100–150	300–500	500	150–250	300

Since some time always elapses before practice adapts itself to technical progress, in most offices one encounters illumination levels which are lower than what are to be considered the most economical. As long as the level is not too low the difference is only a question of utility. It is clear, however, that at too-low intensities phenomena must occur which can no longer be expressed purely in money value but which already belong to the sphere of hygiene. There will then be complaints by the employees of fatigue and headache. General experience in the practice of factory and office lighting is that the limit above which these phenomena are no longer frequent for activities such as reading lies at about 100 lux.

THE LIVING ROOM

In the case of the illumination of the living room the situation is quite different from that of the illumination of offices, because the living room is used not only for certain activities such as reading and mending but is alternatively also the cozy gathering place of the family, the festively lighted reception room, or the quiet surroundings where rest is enjoyed. In order to obtain suitable light distribution in all these cases different illuminations will have to be installed which can be used separately or in combination.

In almost all living rooms illumination intensities are found which lie far below what is desirable in a workroom. If the eye protests too strongly, recourse is usually had to extra local illumination, which, however, when several persons are working at the same time, cannot be considered a satisfactory solution.

At present it is without doubt technically possible to install an esthetically satisfactory living-room illumination of sufficiently high level, and in this respect two points have been found to be of great importance.

(1) The esthetic acceptability of an illumination depends very much on the relation between the brightnesses of the surfaces in the room (table cover, ceiling, walls). With a very light table covering the surroundings should also be light since it is found that with increasing brightness great contrasts make a more unpleasant impression. Dark walls form a great contrast with the working surface; from economical considerations they also hinder the employment of indirect lighting, which is so useful for reducing contrasts, and thus quickly set a limit to the illumination intensity. In interiors with light walls and not-too-dark upholstering, illumination intensities of 150 to 200 lux are much more easily attainable than in darker surroundings.

(2) The level of the illumination considered as being "cozy" or "pleasant" is related to the color of the light. For the afore-mentioned illumination intensities of 150 to 200 lux no unpleasant effects are experienced with the reddish light of incandescent lamps, but a whiter light, more nearly approaching daylight, may in some cases give the whole interior a more agreeable aspect. The possibility of such an improvement in color is now offered by the development of luminescent lamps.

Automotive Gas Turbine

THE possibility of developing a small gas turbine in the near future for automotive use is entirely feasible according to an article in *Canadian Automotive Trade*, December, 1946, by G. L. Lentz, Menasco Manufacturing Company. He reveals that his company has designed a power plant which could be readily adapted to power road vehicles and would compare with reciprocating engines of the same power rating. The gas turbine, as designed, would have the following approximate characteristics: Weight, 200 lb; power, 100 to 400 hp; size, 15 in. in diameter and 50 in. in length, which includes the drive gear and the hydraulic or electric generator; rpm, 50,000; fuel economy, 0.5 lb per hp hr.

In the automotive field the gas-turbine power plant might have the following advantages: Ease of installation; ease of maintenance; freedom from vibration allowing simple mounting; negligible maintenance; reduced overhaul cost; one control lever with no carburetor needed; small radiator required, if any; small amount of cooling air; air conditioning of automobile interior easily obtained; low specific weight; smaller overall dimensions; less consumption of lubricating oil; cheap fuels can be used; operation does not require spark plugs for continuous operation, only for starting; reduced manufacturing costs; the size and shape of the power plant lends itself to better body contours and streamlining; generally, more space will be available for storage; simplicity of internal structure of frame of automobile.

It is possible to install the gas turbine in the conventional position forward of the drive without any major difficulties. With this installation it would be possible to have a body style that would be ultrastreamlined with a sharp narrow nose. The hood of the car could be short and low to the ground, giving excellent visibility.

However, it is believed that the gas turbine is better adapted to a rear installation. Here it is possible to get a streamlined

body, the so-called "tear drop" shape. The visibility would be undeniably better than other designs. Other features that make this an attractive design are serviceability of the turbine, comfort of the passengers, and ease of manufacture of the body.

All-Crystalline Porcelains

NEW all-crystalline porcelains, having exceptional mechanical and dielectric strength at temperatures extending up to 2000 F, have been developed in the Porcelain and Pottery Laboratory at the National Bureau of Standards. Such porcelains are particularly valuable for sustaining loads at elevated temperatures, as electrical insulators at elevated temperatures, and as insulators for such special applications as aviation spark plugs and radar transformers.

The composition of these new porcelains is characterized by the use of such materials as alumina, beryllia, zirconia, and thoria, with minor additions of other metallic oxides, and by the absence of silica. A representative high-beryllia porcelain contains 84 per cent beryllia and 8 per cent zirconia, with small amounts of lime and alumina; a typical high-zirconia composition is 80 per cent zirconia, 10 per cent beryllia, and 10 per cent magnesia.

In 1940 the Bureau began a series of investigations to develop glass-free ceramic bodies of the porcelain type which would have simple compositions favorable to high mechanical strength, particularly at elevated temperatures, and good resistance to thermal shock, properties not found in the conventional porcelains.

The work was accelerated by the wartime demand for a material that would resist deformation at temperatures up to 2000 F for use in jet-propulsion and gas-turbine engines. A decided advantage of ceramic materials for this purpose, if other properties are satisfactory, is their low density as compared with the high-temperature metallic alloys. Accordingly, the investigation was extended under the sponsorship of the N.A.C.A. to include strength and creep characteristics in pure tension at temperatures ranging from 1500 F to 2000 F. On the basis of preliminary tests, six compositions were chosen for further study, and tension specimens were made commercially from specifications furnished by the Bureau.

Tensile tests require perfect alignment of the stressing members and freedom from bend of the specimen. The supporting members must be of a material that will withstand the stresses and temperatures involved. Therefore adapters, through which stress may be applied to the specimens, were perfected. These adapters are porcelain cylinders (all of the adapters were made from the same experimental composition), threaded internally on one end to receive the tension specimens and externally on the opposite end. The assembly of a tension specimen and two adapters is of such length that the outer ends of the adapters protrude from the furnace. The adapters, in turn, screw into brass heads which connect through universal joints to the loading device.

Creep or extension of the specimens under load is indicated by a gage similar in principle to those used at the Bureau for measuring creep of metals. Fabricated from platinum-rhodium alloy, it consists of a cutaway tube and a wire that moves freely in this tube. When cemented to the specimen in two places, relative movements of the specimen are determined by observing reference lines on the wire and on the cutaway section of the tube. By a special optical instrument, measurements of the creep may be observed with a precision of 1 micron and readings interpolated to 0.1 micron. Two gages, 180 deg apart, are used in each test.

Tests show that all of the compositions are resistant to deformation or creep at temperatures up to 1800 F for long periods of time. A typical specimen, for example, showed an elongation of 0.23 per cent after a total of 2600 hr, during which the applied stresses ranged from 9000 to 14,000 psi. At temperatures of 1900 F and higher, however, the tendency to creep is more pronounced and appreciably lower stresses produce a creep rate measurable by the hour.

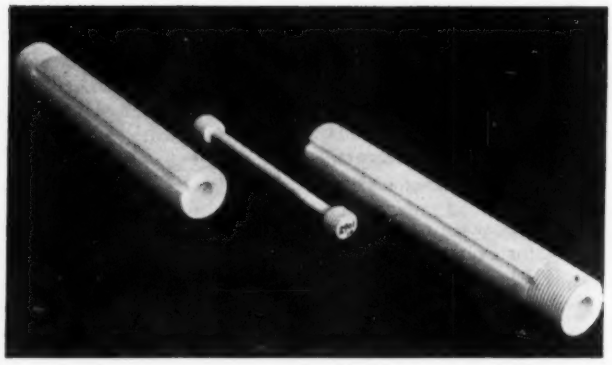


FIG. 4 A PORCELAIN SPECIMEN (CENTER) FOR TENSION TESTS AT ELEVATED TEMPERATURES AND CERAMIC ADAPTERS THROUGH WHICH STRESS IS APPLIED

Scientific Crime Detection

THE science of metallurgy has for many years been an efficient ally in the Federal Bureau of Investigation's scientific crime-detection program, according to an article by J. Edgar Hoover, director, Federal Bureau of Investigation, appearing in *Steel*, Jan. 20, 1947.

Those familiar with metallurgy and the techniques and methods used in the examination of metals and analysis of their properties will be interested in seeing how this science has been utilized to advantage in the FBI's laboratory.

Now in its fifteenth year and with an inventory estimated at more than one million dollars, the laboratory is well-equipped with scientific and precision instruments to offer all duly constituted law-enforcement agencies scientific examination of evidence found at the scene of the crime or developed during the course of an investigation.

During the past year alone, the FBI laboratory conducted 67,229 examinations of evidence. Law-enforcement organizations representing each of the 48 states and two territorial possessions were among the contributing agencies.

Many of these examinations called for metallurgical examinations. Often the findings of this type of examination figured prominently in establishing the guilt of a suspect or the innocence of an accused individual.

Recently, several lengths of pipe, pipe caps, electric detonators, and leg wires used in electric detonating devices were submitted to the FBI laboratory. The case involved the bombing of an office of a furniture-manufacturing company in a southern state, resulting in the death of an employee. Found in the demolished area where the remains of a booby trap which had contained three sticks of dynamite prepared with electric detonators and so arranged that, at the time the electric furnace was plugged into the outlet, it would explode.

The victim unwittingly had acted according to the murderer's plans and on plugging the cord into the outlet had been immediately killed by the explosion.

To the FBI laboratory examiner was assigned the task of determining whether two unexploded pipe bombs also found

in the room were similar to several lengths of pipe, pipe caps, detonators, and leg wires obtained from the personal effects of a fellow employee of the dead man.

Metallurgical examinations corroborated the theory of the local police. The test pipes and the threads on the test pipes made by machinery available to the suspect were similar in every respect to those appearing on the bomb pipes. Likewise, holes drilled in the caps at the end of the pipe bombs were similar to those which were made by either of the two bits found in the suspect's toolbox.

Taken to trial, the suspect confessed his crime and was executed.

With keen appreciation FBI laboratory experts handle the equipment utilized in conducting metallurgical examinations. To them, the spectrograph has proved its worth time and time again, particularly for its sensitivity and certainty. Equally important is its ability to offer unquestionable analysis of evidence too minute to be subjected to chemical examination.

Spectrographic analysis enabled a Pennsylvania police department to solve a local burglary. The telephone cord in the victim's house had been cut by the burglar. When the police searched a suspect, a pocketknife was found on his person. The knife together with the cut telephone cord were submitted to the FBI laboratory.

A laboratory examiner made a spectrographic analysis of the particles on the knife blade. Traces of copper and tin were found on the cutting edge of the blade in the same proportions as the copper and tin making up the bronze alloy of the wire itself. Not visible to the naked eye, the presence of the metals was established conclusively through the use of the spectrograph.

The finding of the laboratory expert resulted in conviction of the burglar.

During the wartime emergency, many types of metallurgical equipment were utilized by the FBI in its task of protecting the internal security of the nation. Among them the metallograph proved its indispensability through its accurate and definite analysis of the crystalline structure of the metal itself.

Defects in metal products were speedily detected through use of the Magnaflux. This equipment is now being satisfactorily utilized for peacetime crime-detection purposes.

Also deserving honorable mention are the other instruments utilized in the FBI laboratory in connection with physical metallurgical examinations. They are: Electric muffle furnace with recording and temperature-controlling units, metallographic polishing equipment, hardness tester, tensile tester, and industrial x ray.

In conjunction with spectrographic examinations the FBI laboratory is equipped to conduct other examinations on metals including the use of the high-temperature combustion furnace for determining carbon content. Analyses to determine chemical composition are covered by gravimetric, volumetric, electrolytic, and colorimetric examinations.

Jet-Propelled Flying Wing

A JET-PROPELLED flying wing, the AW52, has been constructed by Sir W. G. Armstrong Whitworth Aircraft Limited, Baginton, near Coventry, England, the details of which are given in the Jan. 3, 1947, issue of *Engineering*.

The AW52 is of all-metal construction. It weighs about 30,000 lb and has a span of 90 ft and a wing loading of 25 lb per sq ft. The gross wing area is 1314 sq ft, the wing aspect ratio is 6:16, while the angle of sweepback on the line joining the quarter-chord points at root and tip is $24^{3}/_{4}$ deg. The total area of the fins and rudders is 75 sq ft, the angle of the slotted flap at take-off being from 25 to 30 deg, and at landing 40 deg. The outer wings are swept back 35 deg at the leading edge, and the thickness-chord ratio is 18 per cent. Owing to this sweepback there is a tendency for the outflow toward the tips to be very pronounced at slow speeds, and thus for a premature tip stall to occur. To prevent this, a series of narrow slots 0.25 in. wide have been formed along the wing surface in the direction of the span and at about 0.5 in. from the leading edge. These slots are connected by ducts to two large compartments formed in each outer wing, the compartments, in turn, being connected to the intake ducts of the compressor. The connecting pipes to the intake ducts feed into a compartment just behind the leading edge, while the duct opening which is of square section, is closed by upper and lower flap valves. These flaps come into action automatically, thus controlling the suction when throttling occurs or when the pilot's stick is pulled right back. This boundary-layer suction equipment is intended only for use when the airplane is approaching the stall; it is not employed to improve the performance. The leading edges of the wings are provided with thermal de-icing arrangements, the heat for which is drawn from the engine jet pipes.

Longitudinal and lateral control are effected by one control surface on each wing, which fulfills the functions of the normal elevator and aileron. This controller, as it is called, is carried

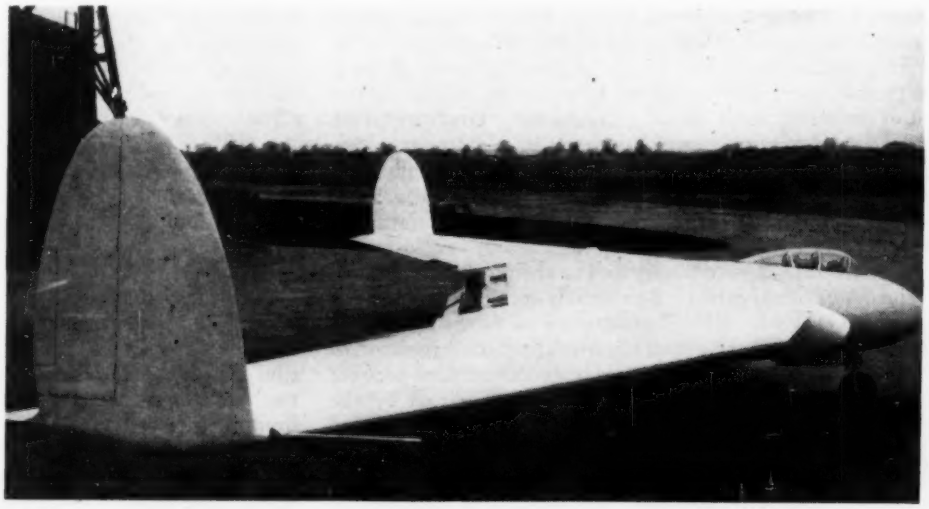


FIG. 5 JET-PROPELLED FLYING WING

behind a Dowty hydraulically operated surface, known as the corrector, the main function of which is to provide a powerful trimming device without impairing the lightness of the manually-operated chord controller. Power-operated dive-recovery flaps are fitted to the underside of the wings to provide additional control during high-speed dives. A slotted flap of 27 per cent chord is placed at the afterend of the center section to increase the lift. Fins and rudders are fitted at the wing tips, the area being determined by the stability and control necessary when flying with a single engine. The rudders are differentially geared, so that the excess drag of the one that is outturned and moves farther than the other is additional to the yawing moment produced by the side face.

The airplane is driven by two Rolls-Royce Nene jet engines, the nacelles for which are almost completely enclosed in the wings; each engine gives a static thrust of 5000 lb. The intake extends forward of the leading edge of the wing and wide slots at the mouth open into roughly square intake ducts. These contain the suction-control flaps and lead to the pressure chamber in which the engines are carried. The tricycle landing gear, designed and manufactured by Dowty Equipment, Limited, is fitted with twin wheels and tires and has a steerable nose wheel. This landing gear has a long vertical travel so that the airplane can, in emergency, be flown straight on to the ground without flattening out, thus facilitating blind landings. The pilot's compartment in the nose is pressurized and is provided with an ejectable seat so that he can leave the airplane in an emergency, even at maximum flying speed. The airplane is provided with a complete range of instruments and all the control forces and angular displacements will be recorded by automatic observers.

A second version of the AW52, now under construction, will be equipped with two Rolls-Royce Derwent jet engines. It is hoped that the trials of these machines, which are of an experimental type, will provide information enabling larger models, weighing between 90 and 100 tons and equipped with four jet engines, capable of giving speeds of 500 mph, to be constructed.

Adhesion Tester

A POCKET type adhesion tester for organic coatings has been designed by Bell Telephone Laboratories and it is described in the December, 1946, issue of the *Bell Laboratories Record* in an article by R. J. Phair of the chemical laboratories.

The instrument is small enough to be held easily in the hand. It measures adhesion by determining the pressure that has to be applied to a scratching tool in the instrument to make it expose the base material under the finish. The scratching element is mounted at the end of a short cylindrical rod and is pressed by a spring against the surface tested. A threaded sleeve controls the pressure exerted by the spring by squeezing it between the end of the sleeve and a shoulder on the rod. Graduations on the outer end of the rod, which projects through the threaded sleeve, indicate the pressure applied. These parts are supported by a housing which has rollers on which the instrument rides over the surface of the finish. When both rollers are firmly pressed against a flat surface the spring pressure is transmitted directly through the scratching tool to the test film.

The more critical parts of the assembly are the spring and the scratching element. Springs suitable for use in the instrument are selected by comparing their stress-strain characteristics with a standard spring which was chosen to give the desired pressure differences over the range of compression permitted by the design. The spring and scratching tool are futher checked after complete assembly of the device by comparing the adhesional levels obtained with them against a standard instrument on representative coatings. The calibration markings are

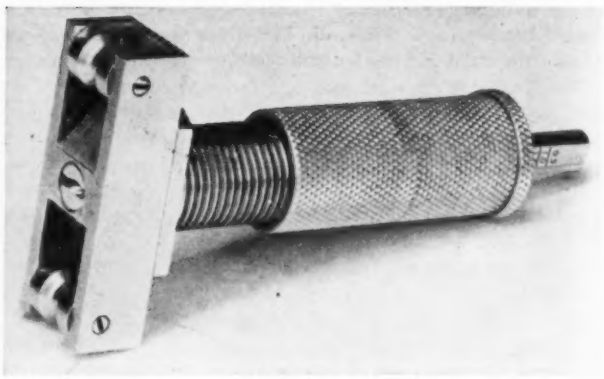


FIG. 6 ADHESION TESTER

then scribed on the upper end of the inner rod. The scratching tool is a steel disk 0.256 in. outside diameter and 0.0625 in. thick. The periphery of the disk is smoothly rounded to a radius of 0.0312 in. and it is hardened, highly buffed, and chromium-plated.

In use the tool is set for minimum pressure, pressed firmly against the coating to be measured so that both rollers are in contact with it, and then pushed with a slow steady motion over the film. This process is repeated with increasing pressure, obtained by turning the threaded outer sleeve an arbitrary amount until the film fails. This occurs when the film is removed by the scratching disk and the base surface is exposed. The adhesional level is then read from the scale on the upper end of the graduated rod. Each division represents about a 500-gram increment and the scale covers a range of from 500 to 5000 grams or from poor to excellent adhesion.

Smokeless Propellant

THE performance of a smokeless propellant in a Jato (jet-assisted take-off) unit designed for Navy carrier-based aircraft is described in a report (PB 32219) on sale by the Office of Technical Services, Department of Commerce, Washington, D. C. Test models powered by the new solventless-extruded powder exhibited high thrust and long-burning capacity without creating deposits of smoky film.

Navy specifications for the experimental work called for development of a Jato unit to be propelled by a practically smokeless powder with an approximate burning time of 10 sec and a thrust of 1000 to 1500 psi in temperatures ranging from minus 15 to 120 F. Jato units then in use were unsatisfactory because the existing propellant when ignited produced a heavy smoky discharge containing finely dispersed potassium-chloride residues. The residues deposited an opaque coating on windshields of following planes and a slippery film on decks. The smoke discharge also interfered with antiaircraft performance. In addition, the unit did not function well at low temperatures.

The new propellant, which has a low heat of explosion and a low burning rate, met the Navy requirements. Known as "H-5," the smokeless-powder charge is of the solventless double-base type. A second propellant, "L-4, 8," a modification of H-5, is long-lived and exhibits a lower operating pressure and temperature coefficient permitting reduction of weight in metal parts. Formulas for these and various other powder charges are given in an appendix to the report. In each of five test-model units, the powder charge was loaded in the chambers in three banks of seven grains.

Design of the propellant chamber in the test models was the same as the Aerojet Jato unit, the only modification being those made in the trap and nozzle assemblies. After burning, caused by ignition of hot cellulose-acetate residues boiling out of the chamber, was prevented by insulation and by a nozzle of the convergent-divergent type threaded into the powder chamber. Of five nozzles tested, a 30-deg cone with a 10:1 expansion ratio had a slight advantage in performance and permitted a reduction in length and weight.

Contained in the report are data on design features of the unit, including external chamber, chamber cap, nozzle, safety cap, igniter assembly, and the internal booster disks, tail, and spacer traps. Information is also given on the composition of the main and compensator powder charges. Emphasis is placed on a test unit, known as Model II, which was selected for production for flight tests at supersonic speeds.

Gasoline Engines

DEVELOPMENT of a new type of lightweight gasoline engine, designed for aircraft and marine use and ranging in horsepower up to 120 hp., has been announced by McCulloch Motors Corporation, Los Angeles, Calif. From tests conducted on prototype engines of 2-cycle, opposed-piston, supercharged design, the company has revealed information indicating extremely desirable performance, coupled with low initial and operating costs. Weight of the 120-hp model is only 150 lb, approximately 100 lb less than any other comparable aircraft engine now available.

Each cylinder contains two pistons, which are opposed and each of which is connected to a crankshaft on its side of the engine. The two crankshafts in turn drive a larger propeller shaft through pinions located at the front end of the engine. The combustion chamber is the cylindrical space enclosed between the two piston heads.

One piston controls the exhaust ports; the other piston in the cylinder controls the inlet port. The crankshafts are timed so that the exhaust ports are opened in advance of the inlet port. This permits most of the exhaust gas to escape before the fresh charge enters the combustion chamber. When the inlet port opens, the fresh charge is forced into the combustion chamber by the gear-driven supercharger. While passing through the inlet port, the fresh charge is given a rotary motion which aids in keeping the fresh charge separated from the residue of the exhaust gases. This arrangement is said to have proved successful in raising the fuel economy of the new engine far beyond anything experienced in conventional 2-cycle engines and equaling the best 4-cycle engines.

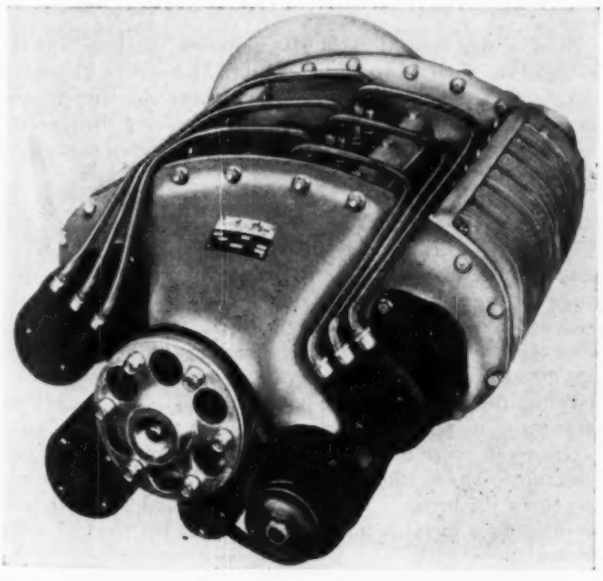


FIG. 7 TWO-CYCLE, OPPOSED-PISTON TYPE, AVIATION AND MARINE ENGINE

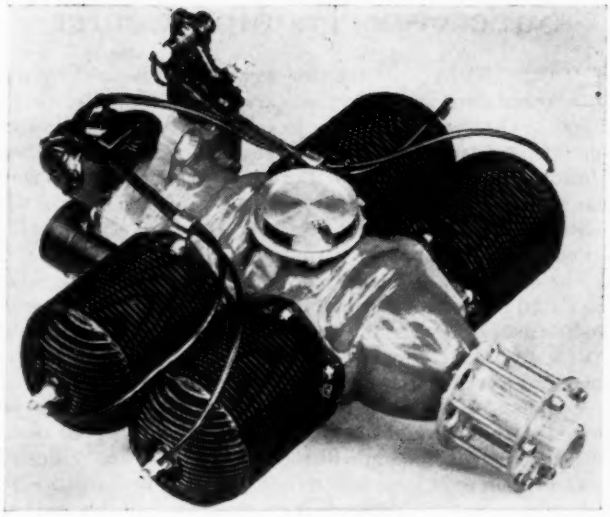


FIG. 8 TWO-CYCLE ENGINE FOR POWERING TARGET AIRCRAFT

A fuel injector discharges fuel into the inlet manifold through individual nozzles for each cylinder. Use of the fuel injector permits normal operation of the engine in any position, a desirable feature for both aviation and marine applications.

The main engine structure, including the integral cylinder block, will be an aluminum-alloy high-pressure die casting. Thin cylinder liners will be shrunk in place. Because both ends of the cylinder are open, honing will be a simple operation. Other engine castings will also be die castings.

Except for the spark plugs, all bolts have heads and nuts of the same size. Thus only one wrench is needed to assemble or disassemble the entire engine. Wherever possible, through bolts are used instead of studs, to permit easier servicing. Accessibility of all parts is another feature of the engine that will find favor with mechanics.

A 2-cycle crankcase-scavenged target-aircraft engine, also developed and produced by McCulloch Motors Corporation, indicates interesting possibilities in future aircraft-engine design, since it develops more than 60 hp yet weighs only 74 lb. Target aircraft with these engines have been flown to speeds well above 200 mph which, taking the scale effect into consideration, permits gunnery practice under the same conditions presented by the fastest fighters.

The engine has four cylinders, with bore and stroke of $3 \times 3^1/_8$ in., making a total displacement of 88.3 cu in. With the exception of the center main, all bearings are the antifriction type. No gears are used in the design, all accessories being driven from the free end of the crankshaft.

Most of the major parts of the engine are designed for die-casting. The complete engine, with magnesium crankcase, die-cast cylinders, and a double-ignition magneto, weighs approximately 68 lb bare. At a propeller speed of 3000 rpm, with 91-octane fuel and compression ratio of 8 to 1, the rating is 53 bhp. The brake mean effective pressure at this point is 79.2 psi, corresponding to an equivalent rating of 158.4 psi in a 4-cycle type at the same output.

Supervisor Training Center

EDUCATIONAL and training techniques advanced by the Armed Forces during the war are now being applied by the Standard Oil Company of New Jersey in an educational project for salesmen, supervisors, and engineers. To supplement its already extensive program of training on the job, the company has recently opened an Esso Training Center in the heart of the business district of Elizabeth, N. J., to serve as a focal point for its entire plan of employee training.

The center is a three-story brick building which represents an initial investment of approximately $400,000. It houses an auditorium, numerous conference rooms, demonstration laboratories, and an amazing array of visual aids designed to supplement the more familiar methods of instruction.

Convinced that the least effective type of instruction for its courses was the straight lecture, the center was designed about the conference method in which everyone takes part. Since all students will have some field training and will be familiar with the subject matter discussed, it is expected that this method will give each student an opportunity to think and to express himself on his problems and to arrive at his own solutions. Charts, posters, models, and similar visual aids created by staff specialists are placed conspicuously about the conference rooms for ready reference.

Speaking to a party of press representatives who were to inspect the center, M. J. Rathbone, president, Standard Oil Company of New Jersey, declared that the center was dedicated to company employees in recognition of the fact that "people want the opportunity to advance in accordance with their own ambitions." He said that his company recognized its obligation to assist young engineers and scientists in their technological advancement and that his company wanted to induce young men to join it.

The principal aim of the center is to stimulate and set standards for the company's local training programs. It serves not only as a school but as an agency staffed to develop materials to make training fast, interesting, and lasting.

The second major function is to take over portions of certain training programs which can be most efficiently handled on a centralized basis. Industrial salesmen, for instance, number only a few in each territorial division of the company. By providing their basic training at the center, duplication of effort is eliminated. Local training will qualify each man to serve the industries peculiar to his locality. A similar policy will be followed in the training given in this country to foreign representatives of the companies affiliated with Standard Oil Company of New Jersey.

The full-time instructors at the center are men of considerable experience with the company, and have a special background and interest in teaching. Each instructor plans and supervises a particular group of courses and conducts some of the classes. Other men, top-flight management personnel as well as specialists in all fields, are called on as needed to supplement the permanent staff.

Students attend the center on company time and full pay. They are selected by the management of each company unit.

FIG. 9 TRAINEES STUDY OPERATIONS OF AN ACID-TESTING PLANT AS DEMONSTRATED BY A WORKING MODEL

Pouring Babbitt Bearings

SIMPLE but effective procedures for pouring Babbitt to produce sound dependable bearings are described by K. T. MacGill, manager, Babbitt and Bearing Division, Joseph T. Ryerson and Son, Inc., Chicago, Ill., in an article in *The Iron Age*, Jan. 9, 1947.

There are many ways in which bearings can be poured, with assurance of equally good results. However, experience has proved that if the basic principles of heat transfer from molten metal through the bearing shell are observed, good bearings with lining tight against the shell should be obtained, regardless of the particular setup or method followed. The average plant or shop usually has or can readily devise the equipment and fixtures that are required. From this point on it is necessary only to follow a few simple fundamental rules.

It pays to always use new babbitt, made of virgin metals. When the proper grade has been decided upon for the service involved, do not mix the virgin material with reclaimed or scrap metal of unknown analysis. While it might appear that re-using old metal is one way to save on bearing costs, it is seldom wise to try and economize by mixing old used metal with new. Too often dirt or other harmful foreign matter will be included, or metals of unlike analysis may not produce the dense close-grained structure required to successfully resist wear.

Using a wire brush, clean all equipment, fixtures, and the inside of the shell thoroughly. Follow this with a blowtorch and further brushing, if necessary. The blowtorch also serves to drive out all moisture from the bearing shell, an important step. The mandrel should be as thin-walled as possible, with ends closed with wood plugs to prevent heat loss.

Put a waste head on top of the shell. This takes care of the problem of shrinkage as the bearing solidifies, assuring sufficient metal to completely fill the bearing area. The waste head is made of a puttylike substance that is especially prepared for the purpose and, as it does not dry out, may be used over and over again. The height of the waste head depends upon the size of the bearing; larger bearings requiring more excess metal at the top to make up for shrinkage.

Before the melt is started, make sure that sufficient babbitt is at hand to pour the entire bearing at one time. This is necessary in order to obtain a dense and completely uniform structure. The melting pot should be placed close to the work; the closer the better. This will prevent heat loss in the ladle as the molten metal is transferred from the pot to the bearing fixture.

Follow the manufacturer's recommendation for correct pouring temperature. Generally speaking, a temperature of from 850 to 950 F is sufficient. After the Babbitt is completely

molten, the best pouring temperature is related to the thickness and size of the bearing being poured. The metal should pour about like water. Heating to a slight excess is not harmful; the only disadvantage being the accumulation of a higher percentage of dross resulting from oxidation. Thick heavy bearings can be successfully poured at a lower temperature than long and thin bearings. The metal must be hot enough to reach the bottom of the mold and start to build up before any sign of setting occurs. One simple method of checking to determine if the metal has reached the correct pouring temperature is to insert a small dry pine stick in the pot. It should burst into flame immediately upon contact with the hot babbitt.

Before starting the pouring operation, warm the bearing shell to a temperature of about 200 F. As previously stated, this serves to drive out all moisture and also prevents too quick or nonuniform solidification of the molten metal. Fill the space completely and as rapidly as possible, continuing pouring until the top of the waste head is reached. Cool the bearing shell by applying water or wet rags, starting at the bottom and working slowly upward. By thus drawing the heat outward, the metal starts to solidify at the inside surface of the shell, adhering tightly to the wall. As the babbitt sets and contracts in this area, the void is filled with hot metal from the mandrel side which in turn is fed from the surplus metal provided by the waste head at the top of the shell.

When the metal has completely cooled and set, if the bearing has been properly poured, the mandrel should not stick but should free itself from the fixture with little effort. While conditions and facilities will vary from shop to shop, if these simple basic rules are followed there is no reason why every bearing produced should not be sound, dependable, and capable of giving long trouble-free service.

New Pyrometer

WITH the recent development of gas turbines and jet engines as practical power plants has come a need for accurate and responsive temperature-sensing instruments. Such instruments would serve not only for evaluating engine efficiency, but also for protecting experimental parts. An improved pyrometer for measuring the temperatures of these high-temperature high-velocity gas streams has been developed by Andrew I. Dahl at the National Bureau of Standards, in co-operation with the Bureau of Ships, Navy Department.

The new pyrometer consists essentially of an ordinary thermocouple junction around which is pressed a small, light, silver shield. The main problem in measuring the temperature of the hot gases is preventing the transfer of heat to or from the thermocouple junction by radiation. The shields formerly used for this purpose are not only bulky, and slow to respond to changes in temperature, but also offer considerable obstruction to the stream of gas. The use of a silver shield overcomes these limitations since silver, being a good reflector and a poor emitter for radiant-heat energy, keeps the temperature of the shielded junction nearly the same as that of the gas.

The junction, made by conventional methods, is inserted $\frac{1}{2}$ in. into a silver tube $\frac{3}{4}$ in. long that is slightly flattened. A thin mica strip is inserted within the silver tube on each side of the junction and the assembly is pressed to form a rigid unit with good thermal contact between shield and junction.

It is reported that the new device was found accurate to within five degrees Fahrenheit in experiments utilizing a stream of gas at 1500 F flowing with a velocity of 250 fps through a pipe with walls at 1200 F. In addition to high accuracy, laboratory tests indicate that this pyrometer responds quickly

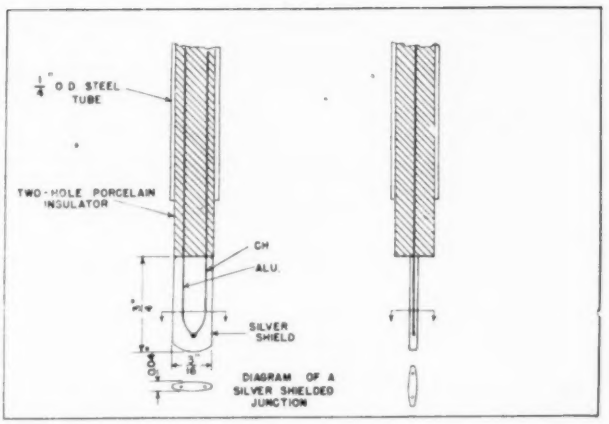


FIG. 10 SCHEMATIC DIAGRAM OF A SILVER-SHIELDED PYROMETER JUNCTION

to changes in temperature, is simple to construct and easy to install, and that the new junction creates a minimum of disturbance to gas flow.

The maximum dimension of the shielded junction need not exceed the diameter of the porcelain tube used to insulate the thermocouple wires from each other. Various types of steel protecting tubes can be used to protect the unit without loss of accuracy or sensitivity. Several of the new instruments have been constructed and sent to commercial turbine manufacturers for service tests in full-scale operating turbines.

Multiple-Element Controls

THE trend in process design toward higher operating pressures and temperatures, higher process rates, greater operating flexibility, and higher control accuracy has complicated the control problem and has led to the development of many types of control actions.

These different control actions have been developed to satisfy certain operating requirements and process characteristics and it follows that satisfactory control is dependent upon the correctness of application to the process.

CONTROL PROBLEM

A paper, "Multiple Element Control Systems," to acquaint operating and designing engineers with the basic elements of multiple-element control systems, was presented by H. H. Gorrie, member A.S.M.E., assistant chief engineer, Bailey Meter Company, Cleveland, Ohio, at an Industrial Instruments and Regulators Division technical session during the 1946 Annual Meeting of The American Society of Mechanical Engineers.

To control a process, three elements must be taken into consideration, namely, energy supply rate (supply); energy demand rate (demand); and demand energy potential (demand potential).

It therefore follows that the ideal control system would be one which proportions the "supply" to the "demand" from actual measurement of these factors and readjusts the supply to maintain the desired "demand potential." Such an arrangement is ideal because it accomplishes the desired results by direct measurement of all of the factors involved. Practically, this ideal system of control is difficult to attain, for in many processes it is impossible to measure both the supply and de-

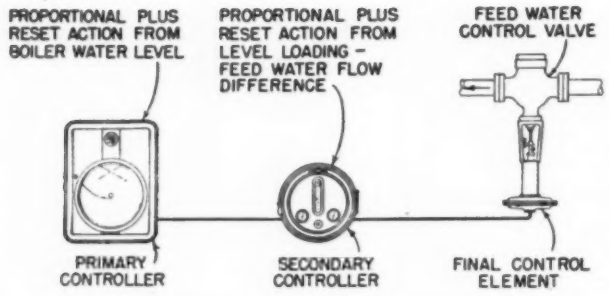

PROPORTIONAL PLUS RESET ACTION FROM BOILER WATER LEVEL
PROPORTIONAL PLUS RESET ACTION FROM LEVEL LOADING - FEED WATER FLOW DIFFERENCE
FEED WATER CONTROL VALVE
PRIMARY CONTROLLER
SECONDARY CONTROLLER
FINAL CONTROL ELEMENT

FIG. 11 APPLICATION OF TWO-ELEMENT GOVERNOR ACTION TO CONTROL OF BOILER FEEDWATER

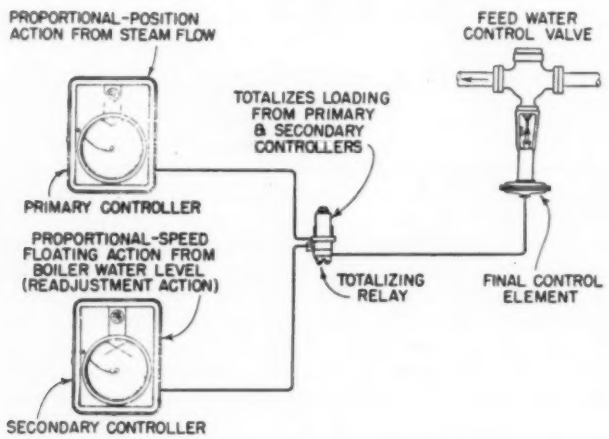

PROPORTIONAL-POSITION ACTION FROM STEAM FLOW
FEED WATER CONTROL VALVE
TOTALIZES LOADING FROM PRIMARY & SECONDARY CONTROLLERS
PRIMARY CONTROLLER
PROPORTIONAL-SPEED FLOATING ACTION FROM BOILER WATER LEVEL (READJUSTMENT ACTION)
TOTALIZING RELAY
FINAL CONTROL ELEMENT
SECONDARY CONTROLLER

FIG. 12 APPLICATION OF TWO-ELEMENT-READJUSTMENT ACTION TO CONTROL OF BOILER FEEDWATER

mand and in others it is possible to obtain only an approximation.

Since the demand potential is also an accurate index of the supply-demand proportion, this single element provides the possibility for complete control of the process without the necessity of other measurements. Controllers utilizing the measurement of demand potential, such as temperature, pressure, and level, to control the entire process, may be called single-element controllers. The vast majority of controllers in operation today are of this type.

MULTIPLE-ELEMENT CONTROL ACTIONS

The I.I.R. Division of the A.S.M.E. defines the controlled variable as "that quantity or condition which is measured and controlled."

Multiple-element control is reserved for processes which cannot be controlled satisfactorily from a single variable.

Multiple-element control is used for the following purposes: (1) Eliminate uncontrolled variables before they have an opportunity to disturb the primary process; (2) eliminate interaction between related processes or control systems; (3) reduce the effects of capacitance, resistance, dead time, and self-regulation by proportioning supply to demand.

Individual controllers may be combined in an infinite number of ways to accomplish these purposes, and therefore it is desirable to consider separately the various types of actions which can be accomplished by multiple-element control.

TWO-ELEMENT GOVERNOR ACTION

The two-element governor action treats the final control element of a primary process as a separate secondary process. The primary controller, instead of positioning the final control element directly from an indication of demand potential as it does in a single-element control, changes the control point of a secondary pressure, temperature, flow, level, or speed controller, which in turn positions the final control element.

In this way the primary process-control agent is proportioned to the demand established by the primary controller and is independent of disturbances caused by such uncontrolled variables as changes in pressure, temperature, flow, speed, or nonuniform final-control-element characteristics.

TWO-ELEMENT READJUSTMENT ACTION

The fundamental requirement for equilibrium in a continuous process involving the transfer, conversion, and storage of energy is to proportion the supply to the demand. Two-element readjustment action partially meets this requirement in that its primary action is roughly to proportion the supply to the demand.

A primary controller is used to position the final control element proportionally to a measurement of the demand, and a secondary controller is used to readjust the final control element from the demand potential. In this arrangement the final control-element position is considered to be roughly indicative of the supply. The rough proportioning of supply to demand partially satisfies the basic process requirement for equilibrium, leaving the readjustment action from the demand potential to correct for inaccuracies in the proportioning system. Process controllability characteristics may be largely disregarded with this type of control, but final control-element characteristics must be considered.

This control action as compared with single-element action, provides greater ability to handle rapid changes in load, greater flexibility of adjustment, and reduces the possibility of interaction between related processes.

THREE-ELEMENT ACTION

Three-element action is the same as that described for the two-element readjustment action except that the refinement of measuring the supply has been added and thus an accurate proportioning of supply to demand is obtained. Uncontrolled variables affecting the final control element and final control-element characteristics are eliminated by the flow-proportioning control, reducing the work to be done by the secondary controller to a minimum.

This system of control combines the good operating charac-

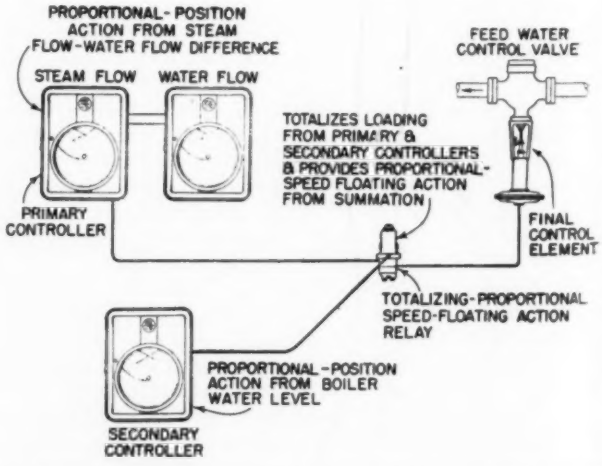

PROPORTIONAL-POSITION ACTION FROM STEAM FLOW-WATER FLOW DIFFERENCE
STEAM FLOW
WATER FLOW
FEED WATER CONTROL VALVE
TOTALIZES LOADING FROM PRIMARY & SECONDARY CONTROLLERS & PROVIDES PROPORTIONAL-SPEED FLOATING ACTION FROM SUMMATION
PRIMARY CONTROLLER
FINAL CONTROL ELEMENT
TOTALIZING-PROPORTIONAL SPEED-FLOATING ACTION RELAY
PROPORTIONAL-POSITION ACTION FROM BOILER WATER LEVEL
SECONDARY CONTROLLER

FIG. 13 APPLICATION OF THREE-ELEMENT ACTION TO CONTROL OF BOILER FEEDWATER

teristics of the two-element governor action and two-element readjustment action. It is capable of great flexibility of adjustment and is adaptable to any type of process where the necessary variables can be measured to obtain stable control at varying demand conditions, or great accuracy at steady-demand conditions.

CALCULATING AND PARALLEL ACTIONS

Calculating action is accomplished by performing calculations involving differences, summation, and ratio in special instruments, using the end product of the calculation as the controlled variable. There is almost no limit to the arrangements possible, but normally this is special equipment developed to satisfy a particular process.

Parallel action is obtained where a single controller establishes a loading index to position in parallel several final control elements of related processes Depending upon the refinement required, readjustment of the various final control elements may be made manually or by secondary controllers. In any case, for the best performance, this type of control requires that the position-flow characteristics of each final control element be approximately the same, in order to minimize the adjustments necessary. Where desirable or necessary, final control-element characteristics or uncontrolled variables affecting the final control element can be eliminated by the use of secondary controllers.

The advantage of parallel action is that it prevents interaction between related processes by parallel control of all control agents.

Parallel-readjustment action is a combination of parallel and two-element readjustment actions. It utilizes the advantages of both fundamental systems to obtain the most desirable type of control for a particular process.

SERIES ACTION

Series action is obtained where a number of independent control systems comprise the complete control system for a complex process. Through process reaction these controllers operate in series to control all the process variables. In reality, this is not a multiple-element control system but merely several single-element controllers combined to form an integrated control system.

The advantage of series control is great flexibility of arrangement, but it is sometimes difficult to adjust because of interaction between various processes. Series control systems are employed to control the vast majority of complex processes, being used of necessity wherever there is no common index of demand or where flexibility is required.

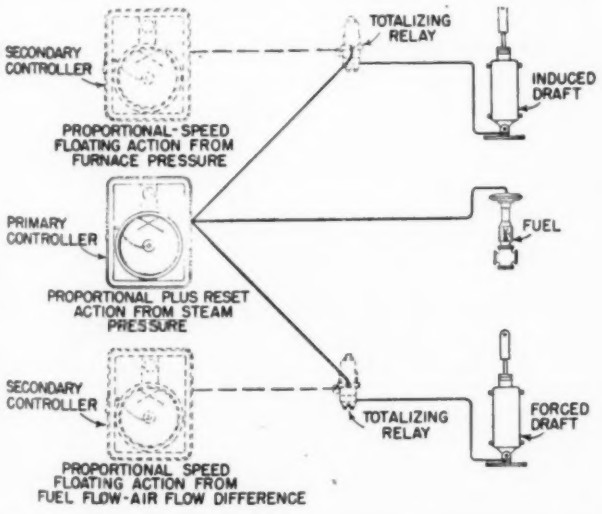


FIG. 14 APPLICATION OF PARALLEL ACTION TO COMBUSTION CONTROL OF A STEAM BOILER

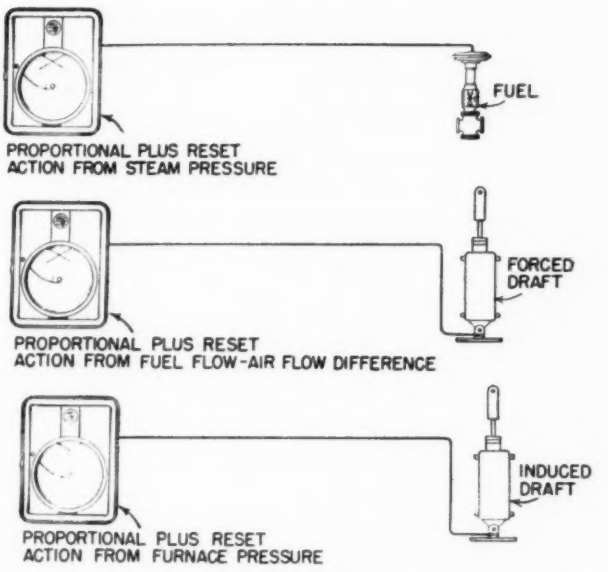

FUEL
PROPORTIONAL PLUS RESET ACTION FROM STEAM PRESSURE
FORCED DRAFT
PROPORTIONAL PLUS RESET ACTION FROM FUEL FLOW-AIR FLOW DIFFERENCE
INDUCED DRAFT
PROPORTIONAL PLUS RESET ACTION FROM FURNACE PRESSURE

FIG. 15 APPLICATION OF SERIES ACTION TO COMBUSTION CONTROL OF A STEAM BOILER

EQUIPMENT DESIGN

To accomplish the multiple-element control actions described requires considerable flexibility in equipment design. Although the individual design of controllers may vary over wide limits, the method of combining measurements of variables for control purposes may be classified into two broad groups, namely, force-balance controllers and differential-motion controllers.

The force-balance type of controller is normally simple in design and in most cases capable of extremely fast action. In practically all cases it is nonindicating or recording.

The differential-motion type of controller is considerably more flexible in its application since calculating functions can be performed between the instrument motion and the motion which is used for control purposes. This type of controller is normally indicating or recording.

Selection depends largely upon the requirements of the particular process, the allowable expenditure for control equipment, the value of permanent records of process performance, and, to some extent, the equipment available by a particular manufacturer.

Electronic X-Ray Counter

DEVELOPMENT of an electronic x-ray counter that accurately records x rays at millionth-of-a-second speed over a wide range of intensities has been announced by Westinghouse Electric Corporation research engineers.

Said to be the first all-purpose tool for the measurement of x radiation, this x-ray detector in high-speed tests has approached the ultimate in sensitivity by providing exact measurement of the smallest x-ray units known as well as intense radiation.

Measuring x rays has always been difficult. The Geiger

counter of the type used at the Bikini atom-bomb tests to warn of radioactivity measures only low intensities of radiation. It is reported that the development of this new counter therefore gives science a valuable tool for fundamental research as well as pointing the way to possible future industrial applications of x-ray equipment.

The device is an adaptation of the photomultiplier, an already existing type of electronic tube which has been used in the past as a supersensitive electric eye to measure light output. This tube can also measure x rays at speeds as high as one millionth of a second and over a wide range of intensities.

Extremely simple in its construction, the new instrument consists of a photomultiplier tube wrapped in a sheet of fluorescent screen which is itself wrapped in black paper. While the black paper blocks out all room light, x rays penetrate to the fluorescent screen. The tube measures the intensity of this fluorescence and can record changes in intensity as rapidly as one every millionth of a second.

The photomultiplier tube, although only the size of a small radio tube, not only operates like a photoelectric cell to respond to visible light rays, but also amplifies that response one million times in order to allow tiny changes in intensity to be measured.

When light rays from the glowing fluorescent screen enter the tube, they strike a metal plate coated with cesium-antimony. This metallic compound is sensitive to visible light rays and light striking the cesium-antimony molecules causes some electrons to be shaken loose from their parent molecules. These free electrons then collide with another plate, knocking loose more electrons.

This cumulative process is repeated at nine plates until the flow of electrons or electric current is amplified some one million times. This final current intensity is recorded, the entire operation requiring only one millionth of a second.

It is revealed that in high-speed tests, the new detector has approached the ultimate in sensitivity by responding to the smallest x-ray units known. X rays do not travel in a continuous procession, but are grouped together in packages known as "quanta." Since x rays can be found in no smaller units, an instrument which responds to quanta themselves is used to record readings for the instrument.

Co-Operative Educational Program

A PROGRAM of co-operation with universities and colleges in the United States and Canada in the field of engineering education, through the distribution of technical literature, was announced recently by T. H. Wickenden, member A.S.M.E., manager of the development and research division of The International Nickel Company, Inc.

The new program will make available useful material for classroom instruction in training students in scientific fields. It has been offered to, and accepted by, a number of important institutions in the United States and Canada which give accredited engineering courses. As rapidly as possible the program will be offered to all engineering schools.

The development and research division will furnish to each institution an exhibit containing approximately 50 specimens of nickel-containing materials; a portable metals-identification kit containing approximately 35 specimens of important metals and alloys for qualitative identification of metals and alloys (spot-testing); literature and other technical and practical information concerning nickel and its alloys; and other data. Motion pictures of the company's mining, smelting, and refining operations will be made available.

Remote-Control Gear

THE Lockheed hydraulic remote-control gear as described in the Dec. 27, 1946, issue of *Engineering*, is an interesting example of the method of regulating the fan vanes and dampers of the induced- and forced-draft fans of the boilers of a generating station from the main control panel of the station, the method having been developed by the Automotive Products Company, Remote Control Division, Tachbrook-Road, Leamington Spa, England.

It is evident that, since the only connection required between the main control panel and the individual control mechanism consists of pipes of small diameter, subject to a pressure due to gravity only when not in actual operation, the lead to remote position is safe and simple. Moreover, it is stated that the system is self-lubricating, is unaffected by extremes of temperature, and retains its efficiency over long periods with a minimum of attention. The controls for any number of points can be arranged on one central panel and can be operated manually, thus rendering the system independent of external sources of power. However, the installation usually adopted includes a motor-driven power unit with manual operating gear fitted as a stand-by.

The principles of a typical manually operated station only are shown in Fig. 16, a diagrammatic layout. The power is derived from the rotary transmitter *a*, actuated by a handwheel and consists of hydraulic pressure delivered to a servomotor or operating a "slave" cylinder, actuating a lever attached to the damper spindle in each case. The slave cylinders are all indicated at *b* in Fig. 16. At *c* is a four-way selector valve with projecting levers, marked *A* to *F*, to correspond with the dampers. At *d* is a fluid supply tank connected to both the rotary transmitter and the selector valve. Neglecting, for the moment, the method of indicating the completion of the desired movement, the actual method of transmitting power may be referred to. The rotary transmitter is, in effect, a four-cylinder hydraulic pump, the four cylinders being arranged radially round the spindle of the operating handwheel. The pistons derive their reciprocating movement from a roller-bearing eccentric on the spindle, contact with the eccentric on the return stroke being effected by a helical spring. Each piston has a central spring-loaded suction valve, while the casing contains corresponding spring-loaded delivery valves. When the slave cylinders are double-acting, the power is transmitted by rotating the transmitter handwheel in the desired direction for appropriate movement of the slave-cylinder piston, the al-

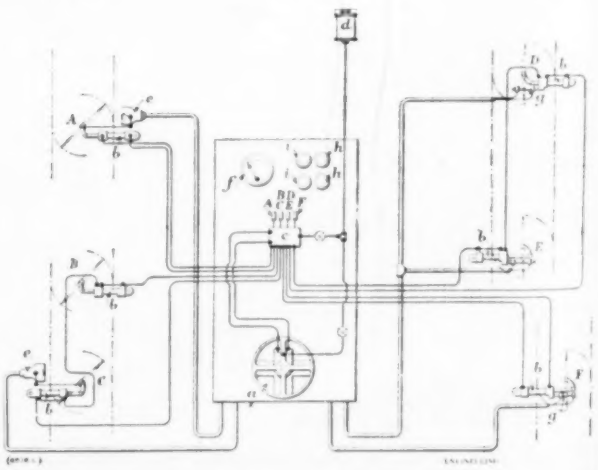


FIG. 16 DIAGRAMMATIC LAYOUT OF REMOTE-CONTROL SYSTEM

teration in the port arrangement being effected automatically. The slave cylinders seen in Fig. 16 are double-acting.

The pressure fluid from the transmitter to the cylinder is directed to the particular point required by manipulation of the levers of the selector valve, the exhaust or return fluid passages being provided through the valve at the same time. The connections are copper pipes of small diameter shown in Fig. 16 by heavy lines. Damper *A* is operated by lever *A* on the selector valve, this particular damper being arranged for independent movement. Dampers *B* and *C*, however, are to be moved synchronously, hence the corresponding lever on the selector valve is indicated with both letters. Dampers *D* and *E* also act synchronously, while damper *F* is again an independent unit. This arrangement is illustrative only; the grouping and duty of the slave cylinders is capable of almost infinite variety. In some cases the cylinders need be only single-acting.

A partially sectioned view of a double-acting cylinder given in Fig. 17, shows in a simplified manner the ingenious automatic locking device adopted to maintain the desired position of the damper immediately the actuating pressure in the cylinder is relieved. Referring to Fig. 17, the piston rod, which is indicated at *a*, carries a divided piston *b*, each half of which has a flange with a conical periphery. On each of these cones, and between them and the cylinder wall, lies a garter spring *c*, which is kept in contact with the wall by a thrust washer *d*, and a common helical spring *e*. The outward radial thrust of the garter springs on the cylinder is sufficient to render the piston and rod immovable as long as no pressure is being exerted by the rotary transmitter, and a positive lock against displacement of the damper from its selected position is thus provided, while no alteration can occur through slow leakage or from other cause. The piston is held in position on the rod by the nut *f*, the sleeve *g*, and the collar *h*. The sleeve carries a freely sliding disk *i* having a flange in line with the right-hand garter spring. When pressure is admitted to the right-hand side of the cylinder, at *j*, the disk *i* pushes the garter spring to a smaller periphery of the piston flange and the pressure on the cylinder wall is relieved, the piston and rod moving toward the left and the left-hand garter spring automatically relaxed. A flanged sleeve *k* on the left of the piston similarly frees the left-hand garter spring when pressure is admitted to the left-hand side *l* of the cylinder and the piston and rod move toward the right. The packing device to maintain tightness between the two ends of the cylinder consists of rings of compressible material *m* on both the sleeve *g*, and the sleeve *k*, the necessary pressure being exerted by the helical springs shown.

Some indication of what has happened at the point of remote control must be given on the panel at which the control movement is initiated. Referring again to Fig. 16, the electrical cables concerned are distinguished from the pipes by being shown as a pair of lines. There are two forms of indicator, namely, one to give the precise position between the "open" and "closed" positions of the damper at any time; the other merely signaling that the damper is either fully open or fully closed. The first type is shown in Fig. 16 as being fitted to dampers *A* and *C*, the indication being given on a dial on the panel. An electrical transmitter *e*, of a type without contacts, is situated near the cylinder and is operated mechanically from the damper spindle lever, the electrical transmission being to the indicating instrument *f*, which has a dial with a pointer operating over a scale showing the whole range of damper movement. Since the dampers *B* and *C* have synchronized movements, only one transmitter is necessary for both. This is shown at damper *C* and indicates on the same instrument as that of damper *A*, an electrical connection on the selector-valve levers making the necessary change-over of the circuits when the lever is operated. Individual indicators are sometimes fitted.

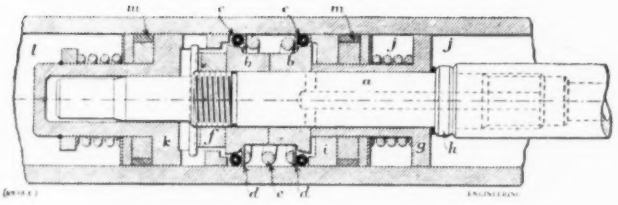


FIG. 17 PARTIALLY SECTIONED VIEW OF DOUBLE-ACTING CYLINDER

The second type of indicator is shown in connection with dampers *D* and *E*. It consists essentially of an electrical limit switch *g* which is actuated at the fully-open and fully-closed positions of the two synchronously operating dampers. The appropriate signal is given by the illumination of one of the pair of lamps, marked *h*, the upper lamp showing a red light for the open position and the lower lamp a green light for the closed position. The damper *F* has a similar limit switch which actuates the pair of lamps *i*. The electrical transmitter and limit switch are fully protected against both moisture and dust.

The layout shown in Fig. 16 does not necessarily represent an actual installation. There may be other remote-control points than those shown; moreover, though butterfly dampers are referred to, the control may actuate other mechanisms. The fluid employed has a freezing point of about —30 C, and a vaporization point of about 135 C. It is virtually noninflammable and is a satisfactory lubricant.

Atomic-Power Laboratory

CONSTRUCTION of the Knolls Atomic Power Laboratory to be built near Schenectady, N. Y., by the Atomic Energy Commission will start this spring, it has been announced by L. E. Johnston, area engineer for the Commission. The laboratory is being erected under the supervision of the General Electric Company, which will operate it for the government when completed. Mr. Johnston said that scientists and engineers will probably begin to occupy the new building by the middle of April.

The new atomic laboratory is to be located on part of a 386-acre tract in near-by Niskayuna. On another part of the property the new General Electric Research Laboratory is now rising. The two laboratories, whose work will closely mesh, are to be operated as a unit under the direction of Dr. C. G. Suits, G-E vice-president, and director of the Research Laboratory.

A number of scientists for the project have already been recruited, said Dr. Suits, and are at work in the present G-E laboratory buildings. More are being employed as rapidly as qualified men and women can be found.

A number of buildings will form the Atomic Laboratory. In one will be located an experimental pile. Such a pile, it is expected, will form the firebox and boiler of future atomic-power plants. Other buildings of the group will be devoted to offices, metallurgy, chemical engineering, and chemistry. Another building will house a 3,500,000-volt electrostatic, or Van de Graaff, generator, for atom-smashing studies.

An earlier government announcement about the new laboratory said that its purpose would be to conduct research in all phases of atomic-power development and that in addition, research on specific problems in connection with the operation of the Hanford Engineer Works in the State of Washington, now operated by General Electric's Chemical Department, would be carried on in the new facility.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Engineers' Salaries

To the Editor:

It has been correctly said that if all the past work of engineers and scientists were wiped out today, the world would be back in barbarism tomorrow. It is interesting to ask why in view of this, many of these men, who are the brains without which our civilization could not function, receive only financial compensation comparable with the wages of unskilled labor.

One who has studied the subject said that when he found a badly paid engineer invariably it was another engineer higher up who was holding down the subordinate's salary. An executive of a concern employing many engineers, with whom the writer talked on the subject, said that he never interfered in engineers' salaries as they were decided by the manager of engineering who was an engineer with much experience in such matters. And some years ago the directors of the research organizations of two of the most important engineering concerns in the United States stated in addresses before one of the national engineering societies that it was inadvisable to pay high salaries to research engineers as the money tended to distract their attention from their work.

The standards of ethics of the legal and medical professions have been frequently criticized. But we rarely hear of a member of either of these two professions assisting in beating down the fee of another member when such fee is to be paid by a third party. In the recent American Society of Civil Engineers discussion wherein some of the older members of the Society endeavored to formulate a code of ethics which the junior members should follow, the writer suggested that as he had never known a junior engineer to act except in accord with a high standard of ethics while he had only too often seen older engineers sacrifice their standards, it was perhaps presumptuous for the older engineers to attempt to lecture the juniors on ethics.

If the salaries of engineers and scientists were increased to ten times their present amounts it would be more in accord with the importance of their work; and if this were done the resultant added burden on the national economy would be less than one quarter of that resulting from the increase in the wages of labor since 1939. One of the important obstacles to be overcome before this can be accomplished is the attitude of the older members of the profession.

W. L. Waters.[1]

[1] Consulting Engineer, New York, N. Y. Mem. A.S.M.E.

The Late Dr. Sanford A. Moss

To the Editor:

I have read with great pleasure the delightful reference to the late Dr. Sanford A. Moss on pages 1027–1028 in your issue for December, 1946.

Dr. Moss has been a correspondent of mine for some years and I had, without ever seeing him, felt just that personal affection for him which is so strongly evident in your memoir. He first wrote to me after reading some notes which I contributed to *The Engineer* on the identity of the inventor of the gas turbine. Dr. Moss had himself gone closely into the history of this invention and was (as can hardly be doubted) probably the first man who ever used the products of combustion for driving a turbine as we today understand this machine. It was Dr. Moss who urged me to persist in my investigation and I subsequently discovered further details in respect of John Barber which brought me—on their publication—a much prized letter from Dr. Moss.

It was his express intention to cross the Atlantic during the present year and among the excursions which he had hoped to make was a visit to the grave, in the parish church at Nuneaton, of John Barber. I may add that in the letters which I received from him, Dr. Moss stated his complete confidence in the future large-scale development of the gas turbine and he mentioned, in one letter, that this would likely take place during his life-time.

Among the qualities which this noble type of man possessed was a most generous appreciation of the merits of researchers other than himself. He here resembled the illustrious Carnot and those who knew him either personally or (as I did) through correspondence, will ever remember, with admiration, not only his valuable contributions to engineering science but the manner of man he was.

A. K. Bruce.[2]

Turkey Enters the Industrial Age

To the Editor:

A planned and systematic industrialization of this country started with the birth of the Turkish Republic in 1923. Along with this step there began a similar rise and growth of other economic factors, and the whole system is slowly improving in production efficiency as to quality, quantity, and cost price. Certain industries (textiles, paper, sugar, cement) are already nearing the point of self-sufficiency in all phases of national life and a co-ordination has been established between nationalization and individualism.

Most of the significant activities of the country are regulated by the State.

The country is rich in natural wealth such as water, forest, and mining resources. The area is 300,000 square miles, the population is nearly 20,000,000, and the number of registered industrial workers is 275,000. The length of highways is 12,500 miles, of railroads 4500 miles, of airways 5600 miles, and shipping totals 250,000 tons. The average value of imports and exports, respectively, for several prewar years is $40,000,000 (£10,000,000) and for several years past there is a favorable excess of exports. ($100 equals 280 Turkish lira and £100 equals 112 Turkish lira). The national budget has gone up from

[2] Senior Partner, Robert Bruce & Sons, Moorgate Hall, Moorgate, London, England. Mem. A.S.M.E.

$80,000,000 (£20,000,000) of the prewar years, to $320,000,000 (£80,000,000) and the over-all price index, relative to 1938, is around 400 per cent. The financial organ of the Government is Merkez bank (capital: $5,400,000, £1,400,000). Sumer bank (capital: $54,000,000, £14,000,000) finances and operates with 30,000 workers, 60 units of industry. Eti bank (capital: $36,000,000, £9,000,000) does the same with 40,000 workers for mining and power developments. Activities of these banks are as follows:

Karabuk Iron and Steel Plant (capital: $15,000,000, £3,700,000) has 4 open hearths, and 2 blast furnaces (capacity: 250 tons daily each) of which only one is in continuous operation at a time. Yearly production of pig iron is 69,000 tons, of steel 61,000 tons, and of rolled products (sheet, strip, bar, shapes) 56,000 tons, of cast-iron pipe 7700 tons, as well as varying amounts of the usual by-products. (Another plant at Kirikkale also produces steel, rolled products, and rails.)

There are about 12 large-size state-operated (capital: $14,500,000, £3,600,000), and an equal number of privately owned textile plants, producing cotton, woolen, and silk stuffs. Among these there are 66,000,000 yd of cotton, and 4,500,000 yd of woolen textiles per year.

There are, furthermore, 4 sugar refineries, 6 cement mills, 2 paper mills, 1 leather and shoe factory, 1 glass-products factory, 6 tobacco-products plants, and 1 tile and brick factory. Yearly production of industrial power sometimes reaches 200,000,000 kwhr of municipal energy also about the same, of cement 300,000 tons; of glass products 7500 tons, of paper 13,500 tons, of sugar 81,000 tons, and of shoes 1,000,000 pairs. Besides several military, naval, and aircraft establishments, there are many promising concerns in the fields of civil-aircraft production, airlines operation, agricultural implements, railroads, maritime enterprise, and lately, automotive, motor, and machinery industries. There are many private factories successfully engaged in the food and dress products, and domestic goods, rubber and cable products, rope and nails industries, as well as several electricians' and machine shops, using in all about 450,000 hp.

The yearly production of coal is 3,500,000 tons, of lignite 590,000 tons, of iron ore 100,000 tons, of chrome ore 100,000 tons, of blister copper 10,000 tons, and smaller amounts of lead, sulphur, asbestos, manganese, borax, molybdenum, antimony, and mercury. A comprehensive undertaking that is about to be put into execution is the electrification of most of the industrial regions of the country. This will be effected by an interconnected system of hydroelectric developments and lignite steam central stations. There are in prospect several other projects for industrial expansion.

Turkey is getting industrialized and the coming years will see her in the ranks of nations of this category.

AHMET RÂIF TANEY.[3]

[3] Mechanical Engineer, Makine Y. Muhendise, Ankara, Turkey. Jun. A.S.M.E.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Gas Turbines and Jet Propulsion for Aircraft

GAS TURBINES AND JET PROPULSION FOR AIRCRAFT. By G. Geoffrey Smith. Aircraft Books, Inc., New York, N. Y., 1946. Cloth, 5¼ × 8½ in., 265 pp., 207 figs, $5.

REVIEWED BY D. M. SHACKELFORD[1]

THE similarity between the fourth edition of G. Geoffrey Smith's "Gas Turbines and Jet Propulsion for Aircraft" and the first edition of the book, first published in this country in 1944 lies almost exclusively in the title. From a slim paper-bound volume of just seventy-six pages the book has grown to two hundred and forty-six pages of the most recently released information on jet propulsion and allied subjects.

The preface of the new volume is written by Gen. Carl A. Spaatz, Commanding General, United States Army Air Forces. The Introduction is by Mr. Charles E. Wilson, President, General Electric Company, first American producers of jet engines, and the Foreword by Sir Geoffrey de Havilland, C.B.E., F.R.Ae.S., famed jet-plane designer. Also included are excerpts from recent lectures by prominent engineers, including Dr. H. R. Ricardo, Dr. S. G. Hooker, Major F. B. Halford, Air Commodore F. R. Banks, and others.

The author briefly reviews the historical background of this subject, and gives detailed design and performance data of most extant jet-propelled planes and engines in the United States, Great Britain, and Germany. He also mentions that Russian designers are known to have been studying gas turbines since before the war.

Mr. Smith covers in some detail the theoretical principles involved in the design and construction of gas turbines and the practical considerations of their test, operation, and maintenance. He states briefly the aerodynamic problems inherent in proposed aircraft for flight at supersonic speeds, and discusses at length such allied subjects as tailless aircraft, flying wings, guided missiles, and flying bombs. Of especial interest to gas-turbine engineers are the chapters on combustion systems and metallurgy.

While not postulating much that is new, the fourth edition of "Gas Turbines and Jet Propulsion for Aircraft" gathers together in one volume most of the recently released information on wartime research, and should prove valuable as a ready reference for anyone wishing to bring himself up to date on developments in the aviation field.

[1] Assistant to Chairman, A.S.M.E. Gas Turbine Co-Ordinating Committee.

Precision Hole Location

PRECISION HOLE LOCATION. By J. Robert Moore Special Tool Co., Bridgeport, Conn., 1946. Fabrikoid, 7 × 10 in., 448 pages, 317 illustrations, 97 charts and tables, $5.

THE author writes quite frankly around jig-boring and jig-grinding machines developed by the Moore Special Tool Company. He has prepared an outstanding textbook on the introduction of production methods to the toolroom. Photographs are used freely throughout and all photographs are

placed adjacent to the text involved. He points out that while highly accurate machines have been developed for surfacing, little or nothing has been done to improve the methods used in the past for locating holes in dies, drill jigs, gages, and fixtures. He then goes on to show how specialized machines have improved the technique of toolmaking.

The three fundamental steps in hole location which must be considered regardless of the method used are defined and the principles involved are analyzed. With this background a typical die is used for the development of the methods of hole location and an explanation of the errors to which such layout methods are subject.

A very thorough analysis of the conditions that must be met in the construction of precision machines follows, with a description of the methods used to meet and overcome the errors that are inherent in such vital elements as the lead screw.

Having established the needs and requirements of the toolmaker, Mr. Moore takes up the construction of the Moore Jig Borer and the Moore Jig Grinder in great detail. Besides showing why these precision machines are applicable to the toolroom, the discussion introduces many examples of work actually done.

Finally Mr. Moore develops the desirability of interchangeability for dies, jigs, and other tool parts. He points out how displacement of the hand method by adequate machine methods can not only introduce exact duplication, but can lead to an interchangeability of parts that leads to advanced toolroom practice.

An important section of this book is that on the location of holes on circles. Recognizing the involved calculation necessary to laying out a ring of holes, W. J. Woodworth and his son, J. D. Woodworth, have developed diagrams and tables covering the location of from three to one hundred holes on circles of any diameter. By means of these tables the rectangular co-ordinates and the cord of the holes can be determined through the use of factors based on the diameter of the required circle. The angle of a hole is taken directly from the tables.

These tables have been in use for over two years and Mr. Moore recommends them very highly on the basis of time saving and absolute accuracy obtained. The complicated mathematics generally involved is reduced to simple multiplication which can be carried out on a calculating machine. Examples for locating holes by both the polar and the rectangular co-ordinate method are given in explanation of the application of the tables.

In preparing this book, Mr. Moore has made a real contribution to the art and science of "hole making."—R. B. S.

Diesel-Engine Practices

STANDARD PRACTICES FOR LOW- AND MEDIUM-SPEED STATIONARY DIESEL ENGINES. Diesel Engine Manufacturers Association, Chicago, Ill., 1946. Third edition. Cloth, 6 × 9 in., 157 pp., 25 illus. $2.50.

REVIEWED BY EDGAR J. KATES[2]

THIS new edition of "Standard Practices" supersedes the 1935 edition, revision of which was demanded by new developments and changing procedures. It applies to stationary Diesel engines running at speeds up to approximately 750 rpm.

Intended for Diesel-engine users, prospective buyers, and consulting engineers, the book includes a wide range of topics, such as definitions, standard performances, governors, torsional vibrations, auxiliary equipment, generators, and selection of engine sizes.

Mainly, the book will serve to promote the intelligent purchase and correct installation of Diesel power plants rather than their operation and maintenance. The advice given is sound and practical—just what an engineer needs when preparing to build his first Diesel-engine plant, and helpful even after he has acquired considerable experience. It is unfortunately true that many poorly designed Diesel power plants are to be found in which well-built engines have been improperly applied and installed. The designers of such plants would have profited greatly by utilizing the information contained in this volume.

While it is gratifying to note that the tolerance permitted in applying guarantees of fuel consumption has been reduced from 5 per cent in the previous edition to 3 per cent in this one, even the latter figure is inconsistent with guarantees commonly stated in three significant figures. In fact, to this reviewer, it seems illogical to permit any tolerance in fuel-consumption rate attributable to variations in density of intake air within the narrow range specified. Such variations in density, while slightly affecting the power output, will not appreciably change the fuel-consumption rate. Furthermore, even if the effect of varying density must be allowed for, it should be done by means of correction factors based on the intake-air temperature and barometric pressure, instead of by permitting a fixed over-all tolerance.

Another inconsistency appears in one standard which permits harmful torsional vibrations to occur as close to normal speed as 10 per cent while another permits engine governors to let the speed vary as much as 10 per cent.

[2] Consulting Engineer, New York, N. Y. Mem. A.S.M.E.

Books Received in Library

ANALYTICAL METHOD IN DYNAMICS. By H. O. Newboult. Clarendon Press, Oxford, England; Oxford University Press, New York, N. Y., 1946. Cloth, 5½ × 9 in., 81 pp., diagrams, charts, $2.50. This small book treats various topics in dynamics in ways that are intended to supplement the ones used in most textbooks. Special subjects dealt with are indicated by the chapter headings: two-dimensional dynamics; three-dimensional dynamics; applications of moving axes; the motion of a top; the motion of an inextensible flexible chain; and motion about a fixed point.

COLD WORKING OF BRASS, WITH SPECIAL REFERENCE TO CARTRIDGE (70–30) BRASS. By L. E. Gibbs. American Society for Metals, Cleveland, Ohio, 1946. Cloth, 6 × 9¼ in., 104 pp., illus., diagrams, charts, tables, $2. Following a general introduction, the principles and practice of the cold working and annealing of brass are discussed. The effects of chemical composition, and specifically the effect of some ten important metals are considered. A chapter is devoted to the causes, identification, and avoidance of "season cracking." The manufacture of cartridges is dealt with, with special attention to microstructure during the process, and the book is concluded by a discussion of special properties and physical testing methods.

DESIGNING WITH MAGNESIUM. American Magnesium Corporation, subsidiary of Aluminum Company of America, New York, N. Y., 1945. Fabricoid, 5¼ × 8½ in., 323 pp., illus., diagrams, charts, tables. The rise in the use of magnesium as a structural material is reflected in this new book. The early chapters discuss the properties of magnesium, when and why magnesium is desirable, and the choice of fabrication methods. Succeeding chapters take up these fabrication methods in detail, with critical comments on their special features or faults with regard to various uses. The last three chapters present design considerations for casting, forging, and structural work. There is a large section of tables of technical data relating to magnesium.

ELEMENTARY HEAT POWER. By H. L. Solberg, O. C. Cromer, and A. R. Spalding. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1946. Cloth, 5½ × 8½ in., 480 pp., illus., diagrams, charts, maps, tables, $4.75. This new text aims to develop an understanding of the functions, principles of construction, and actual performance of heat-power machinery as a preliminary to the study of engineering thermodynamics. Consideration of matter and energy, fuels and combustion are first given, followed by chapters on internal-combustion engines, fuel-burning equipment, and steam-generating and utilizing installations. Pumps, compressors, and other auxiliary

equipment are dealt with, and there are also brief chapters on the gas turbine and mechanical regrigeration.

ELEMENTARY MATRICES AND SOME APPLICATIONS TO DYNAMICS AND DIFFERENTIAL EQUATIONS. By R. A. Frazer, W. J. Duncan, and A. R. Collar. Cambridge, England, University Press; The Macmillan Company, New York, N. Y., 1946. Cloth, 6 × 9½ in., 416 pp., diagrams, charts, tables, $4. The subject of matrices is developed with special reference to its applications to differential equations and classical mechanics. Designed for the practical mathematician, the general scope of the book is sufficiently elementary for the student of applied mathematics with no previous knowledge of the subject. A good portion of the book deals with aerodynamics. For examples of applications of dynamical theory, problems relating to the oscillations of airplane structures have been chosen. A brief description of some tests in the part played by friction in the motion of dynamical systems is included.

FOUNDRY SAND TESTING HANDBOOK, Standards and Tentative Standards adopted by the American Foundrymen's Association. Fifth edition, 1944. American Foundrymen's Association, Chicago, Ill. Cloth, 6 × 9¼ in., 176 pp., illus., diagrams, charts, tables, $3.50. This publication provides a standard reference book on methods of testing and grading foundry sands and clays. It includes not only the standards accepted by the American Foundrymen's Association and the tentative standards, but also data on tests now in use but not yet considered as standard procedures. There is a glossary of terms, and over 450 references to American and foreign literature are listed in a bibliography on sand testing and control.

FUELS, COMBUSTION AND FURNACES. (Chemical Engineering Series.) By J. Griswold. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, 6 × 9½ in., 496 pp., illus., diagrams, charts, tables, $5.50. Broad in scope, this new book provides an up-to-date chemical engineering text in an important field. It covers the fundamental background and the more essential specific details of the technology, combustion properties, and utilization of fuels, as well as the apparatus and equipment involved. It also introduces the student to petroleum-refining technology and engineering, chemical-engineering thermodynamics, chemical kinetics, refractories, and the process industries that use furnaces. A bibliography of available films is correlated with the text as supplementary material.

FUELS AND FUEL BURNERS. By K. Steiner. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1946. Cloth, 5¼ × 8½ in., 394 pp., illus., diagrams, charts, tables, $5. The nature, occurrence, and properties of fuels are treated from the viewpoint of domestic and commercial heating. Considerable space is devoted to the design, construction, installation, and operation of stokers, oil burners, and gas burners used in heating plants of residences, commercial buildings, and moderate sized steam plants. A special chapter on wood fuel is included, prepared by the U. S. Forest Service, and there is a rather complete discussion of automatic-control methods and apparatus for heating systems, including both conventional electric and recent electronic types.

FUNDAMENTALS OF SUCCESSFUL MANUFACTURING. By G. G. Hyde. McGraw-Hill Book Company, Inc., New York, N. Y., and London, England, 1946. Cloth, 5¾ × 9 in., 201 pp., diagrams, charts, tables, $2.50. This book provides executives with a basic analysis of the fundamentals of modern manufacturing, in establishing a new enterprise or modernizing an existing one. Stressing the importance of good organization and developing an objective viewpoint of manufacturing problems, the book covers in detail such topics as designing and processing the product, housing the enterprise, personnel practices, management controls, and also covers designing, formalizing, evaluating, and staffing the organization. The case-history method of presentation is used throughout.

HEATING AND AIR CONDITIONING. By J. R. Allen, J. H. Walker, and J. W. James. Sixth edition. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, 6 × 9¼ in., 667 pp., illus., diagrams, charts, tables, $5. The new edition of this standard text has been revised as needed to bring it up to date. In addition to the revision of existing material, a new section on panel heating is included and the principle of a reversed-cycle refrigeration system has been treated from a theoretical and practical viewpoint. A feature of the book is a detailed discussion of the design of an actual air-conditioning system. The book is suitable both for the engineering student and for home study.

HISTORY OF THE BRITISH RAILWAYS DURING THE WAR, 1939-1945. By R. Bell, with a foreword by Sir W. V. Wood. *Railway Gazette*, London, England, 1946. Cloth, 6 × 9 in., 291 pp., diagrams, maps, tables, 25s. This book describes the accomplishments of the British railways in meeting the requirements of troop and material transport, of evacuation problems, and of operation and maintenance with reduced staffs and supplies. Considerable statistical information is included. A wide range of topics is covered, with chapters on docks and harbors, rates and charges, air-raid precautions, and the effects of aerial warfare, in addition to the general traffic and engineering problems. The primary aim has been to deal with the affairs of the four main-line companies under Government regulation, but frequent reference is made to the London Passenger Transport Board.

HOW TO TAKE PHYSICAL INVENTORY. By R. F. Neuschel and H. T. Johnson. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, 6 × 9¼ in., 159 pp., charts, $2. A practical guide, this book presents the principles and techniques for planning and taking a physical inventory. It includes the development of the inventory-taking organization and procedures, the selection and training of personnel, the physical preparation for the inventory, and the summarization and verification. The appendix contains a detailed manual of inventory instructions, applying the principles given in the text.

INDUSTRIAL REPUBLIC, Reflections of An Industrial Lieutenant. By P. W. Litchfield. Goodyear Tire & Rubber Company, Akron, Ohio, 1946. Cloth, 6 × 9¼ in., 201 pp., illus., charts, $4. Stressing the importance of the individual and the necessity for effective co-operation between capital and labor, the author presents his material in four parts: Part 1 is a reprint of an earlier publication in which the author examined our industrial economy, as of 1919, and suggested remedies for existing ills; parts 2 and 3 cover the respective periods as indicated, "Industry under industrial assembly (1919–1936)" and "Industry under national unions (1936–1946)" as exemplified in the Goodyear plant; part 4 seeks to define the spheres of responsibility of labor, capital, and management in the attempt to realize a "democratic solution."

INDUSTRY AND SOCIETY, edited by W. F. Whyte. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, 5½ × 8¼ in., 211 pp., diagrams, $2.50. The personnel problems of industry are viewed in terms of the structure of American society. The book explains some of the more serious maladjustments within the industrial system and presents a scheme of analysis for understanding and taking effective action in this field. Among the features of the book are the treatment of race relations, differences in individual motivation related to social status, analysis of status from the viewpoint of the executive, and a chapter on problems in a service industry.

MATHEMATICAL AIDS FOR ENGINEERS. By R. W. Dull. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1946. Cloth, 5¼ × 8½ in., 346 pp., diagrams, charts, tables, $4.50. This book gives engineers many basic mathematical tools essential for dealing with the higher mathematics involved in today's engineering developments. In addition to various chapters dealing with particular mathematical operations, there are chapters from the viewpoint of the types of motion involved, rotation, linear and harmonic motion. The book is intended both for study and reference and supplements the author's larger work, "Mathematics for Engineers."

TREATISE ON MILLING AND MILLING MACHINES. Third edition. Section I. Cincinnati Milling Machine Co., Cincinnati, Ohio, October, 1945. Stiff paper, 6 × 9 in., 182 pp., illus., diagrams, charts, tables, $1. This publication presents a general description of the function and operations of milling machines and their accessories as well as the cutting tools used in these operations. Typical milling examples of actual installations are given to demonstrate proper work handling. The chapters on materials for and types of milling cutters are based on company research. Some forty pages are devoted to the sharpening and care of cutters.

2100 NEEDED INVENTIONS. By R. F. Yates. Wilfred Funk, Inc., New York, N. Y., 1946. Cloth, 5 × 7½ in., 252 pp., $2.50. The first few chapters briefly describe the general subject of invention and its rewards and discuss the patenting and handling of inventions. In the succeeding chapters the specific suggestions are classified in some thirty-five subject groups covering virtually the whole field of commercial endeavor.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by A.S.M.E. members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any item in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

A.S.M.E. BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code may communicate with the Committee Secretary, A.S.M.E., 29 West 39th St., New York 18, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are then sent by the Secretary of the Committee to all members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and is passed upon at a regular meeting.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of Jan. 10, 1947, and approved by the Council on Feb. 11, 1947.

CASE No. 1039

(Interpretation of Par. P-332e)

Inquiry: Is it the intent of Par. P-332(**e**) to require that the separate metallic plate be attached to a boiler of a type and size such as a vertical fire-tube, where the stamping itself is readily visible?

Reply: It is the opinion of the Committee that no separate metallic plate, as provided in Par. P-332(**e**), need be furnished if the stamping on the boiler is as clearly visible from the operating floor as would a plate, if used.

CASE No. 1040

(In the hands of the Committee)

CASE No. 1041

(In the hands of the Committee)

CASE No. 1042

(Interpretation of Spec. SA-213)

Inquiry: Is it permissible to use tubing complying with A.S.T.M. Specifications A 213–46 in place of that complying with Specification SA-213?

Reply: It is the opinion of the Committee that material complying with A.S.T.M. Specifications A 213–46 may be used as a substitute for material complying with Specification SA-213.

CASE No. 1043

(Special Ruling)

Inquiry: Is it permissible under the Code to use chrome-molybdenum steel the physical properties of which comply with an approved Code specification for pipe or castings, and the chemical composition of which complies with Specification SA-213 Grade T 12, for high-temperature pipe or castings? If so, what allowable stresses shall be used?

Reply: It is the opinion of the Committee that material as defined in the inquiry may be used for high-temperature pipe and castings. The allowable stresses at the various temperatures shall be the same as those now permitted for tubing conforming to Specification SA-213 Grade T 12.

CASE No. 1044

(Interpretation of Par. U-77b)

Inquiry: Is it permissible under Par. U-77(**b**) of the Code to hammer test a pressure vessel when subjected to a hydrostatic pressure in excess of $1^1/_2$ times the maximum allowable working pressure of the vessel?

Reply: It is the opinion of the Committee that it is permissible to apply the hammer test to an unfired pressure vessel when the hydrostatic test pressure exceeds $1^1/_2$ times, but not more than 2 times the maximum allowable working pressure.

Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published herewith with corresponding paragraph numbers to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-332 (**e**). Add the following:

Each manufacturer shall furnish, in addition, a metallic plate or plates on which the above data are reproduced for all the items manufactured by him, except when the original stampings are so located on the completed (or assembled) boiler unit that all will be readily visible from one place on the operating floor or platform. These plates, if used, shall be securely attached to the front of the boiler, its setting, or its casing at a place readily visible from the operating floor or platform. All data on such additional plates, including the Code symbol, shall be cast, etched, or stamped and this marking need not be witnessed by an authorized inspector. The letters and figures on these name plates shall be not less than $^5/_{32}$ in high.

PAR. U-68. Replace the second section by the following:

The vessel shall be so designed that a complete radiographic examination of all fusion welded butt joints may be made throughout their length. In applying the rules in Par. U-20, a welded joint efficiency of 95 per cent may be assumed for any butt-welded joint, provided the weld reinforcement is removed substantially flush with the surface of the plate, and on all intersecting butt-welded girth joints the reinforcement is similarly removed within five times the plate thickness (or 6 in., whichever is less) adjacent to any longitudinal joint. On any butt-welded joint where the reinforcement is not similarly removed, a joint efficiency not to exceed 90 per cent may be assumed.

PAR. U-77(**b**). Revise the first sentence to read:

Vessels built in accordance with the requirements of Pars. U-69 and U-70 . . . . . shall be subjected to a hydrostatic test pressure of NOT LESS THAN $1^1/_2$ times the maximum allowable working pressure. . . . . .

A.S.M.E. NEWS

And Notes on Other Engineering Societies

The President's Program of Objectives for 1946–1947

AT the meeting of the A.S.M.E. Executive Committee on Jan. 24, 1947, President Eugene W. O'Brien presented a program of objectives for the current year. The program was discussed and approved by the Executive Committee.

The program follows:

The Work of Vice-Presidents

We are entering on the second year of the plan by which a Vice-President in each Region has responsibility for Society leadership within that Region, particularly in Section, Student Branch, and membership development. The principal objectives are:

Sections: (1) The continuous improvement of the program-making function in the Sections so that an increasing number of members will find interest and stimulus in Section meetings. The Vice-Presidents will help the Sections by some such methods as follows: (*a*) having a Section which has a good program and attendance record report "how" it was done at the Regional Administrative Committee meeting; (*b*) making Regional Administrative Committee meeting in large part an area program-planning meeting, working out methods by which outstanding speakers on topics of common interest are made available to the Sections in the Region by exchange of recommendations and routing of speakers; (*c*) encouraging joint meetings of Sections and Student Branches; (*d*) reviewing and revising the National Speakers List, perhaps developing a Program Makers' Bulletin; (*e*) exchanging ideas as to usefulness of various types of meetings, dinners, and luncheons; (*f*) reviewing and improving the Sections Operations Manual on meetings and program-making.

(2) An active program for junior members within the Sections. One member of each Regional Administrative Committee should be assigned the direction of this program.

(3) Effective relations with near-by Student Branches.

(4) Active participation and identification of Sections in local engineering councils and in appropriate civic and governmental programs. Procedures are fairly well established, but ideas can be exchanged at Regional Administrative Committee meetings.

Student Branches: The promotion, with the help of the Regional Student Branch Committee member, of (1) a successful Student Branch Conference in each Region; (2) an increase in interest and membership in the Student Branches; and (3) closer relationships with near-by Sections. During theyear, the plan for engineering student councils or joint student branches should be formulated for adoption by the Council.

Membership Development: The Society needs "more and better" applications—at least 3000 this year from men of high standing in mechanical engineering—in addition to transfer applications from student members. Goals should be set up by Region and reports made to inform and stimulate the members of the Membership Development Committee and Section and Division officers. They should know the score monthly.

Regional Administrative Committee: A program of action by the Regional Administrative Committee which will improve, within each Region, the operation and influence of Sections and Branches and the resultant service to the individual member by (1) exchange and measurement of ideas and programs; (2) improvements and policies suggested to Council; (3) co-operative scheduling of programs and speakers; and (4) procedures developed toward better identification in public and economic affairs.

Boards

The establishment of six Boards to which Council responsibilities have been or should be delegated will free the Executive Committee for forward-looking policy-making. At the 1947 Spring Meeting, Tulsa, Okla., March 2 to 5, each Board should submit to the Council a program of proposed action, with a request for delegation of necessary authority.

Board on Honors: This Board is changed but little from the old Board, and requires no special attention.

Board on Technology: This Board should direct the new program on research; should balance material presented at meetings with the publishing facilities; should make sure that the ever-expanding field of mechanical engineering is adequately covered; should supervise the *Metals Engineering Handbook, Applied Mechanics Reviews*, and other technical releases.

Board on Membership: This new Board brings together in one group those concerned with increasing membership, with maintaining high standards of membership, and with related individual problems. Its immediate task is to see that membership standards are raised and that many quality prospects are brought into membership.

Board on Codes and Standards: This Board is proceeding on a program of increased scope and intensity which is expected to be financed in large part from increased prices and demands for codes and standards. The Council has approved this program and delegated necessary authority. Monthly reports of progress will be made.

Education and Professional Status: This Board should develop, as its first project, a comprehensive program for the junior engineer.

Board on Public Affairs: This Board will work closely with the representatives of the Society on Engineers Joint Council as it is concerned with governmental and international engineering relations. The Board's first task is to outline its program and state as specifically as possible the types of co-operation that it is prepared to extend on behalf of the Society to the many governmental activities which affect engineering.

Junior Program

The Society should this year formulate and put into effect a program by which the young engineering graduate may be helped in orienting himself to his new professional environment.

Contact: The Secretary's office should develop better methods of tracing the graduate from his engineering school to his first and succeeding jobs, advising the Sections of his coming.

Welcome: Sections should improve the welcome they give to the young man and the opportunities they offer for co-operative work and contact with older members, as well as for self-organization in groups working within the Sections that can provide the young graduates with various satisfactions and opportunities for self-improvement. Such measures as making an active member responsible for one or more sessions could help.

Orientation and Training: Courses, lectures, and advisory groups should be set up by the Sections to aid in the orientation and development of junior engineers but of value also to older engineers, thus promoting greater contact.

Collective Bargaining: Instruction in and solution of problems of collective bargaining will depend upon a careful development of the entire problem of the junior engineer. The actions that the Society can take on this matter will involve following inevitable changes in the laws of labor relations.

Junior Participation: In this program, and elsewhere, first effort should be toward making junior members participating members of each Section, on committees and on leading programs. It will help Section programs, as well as the junior members.

Member Interests

Substantial progress has been made in the study of member interests and in the shaping of a program to meet those interests. This survey is being continued under a committee closely allied to the Board on Technology. During the year it is expected that the com-

mittee will have its recommendations ready for discussion and action by the Board on Technology and the Council.

Publicity

The Society is doing an excellent job in its various activities, but, despite recent improvement, is still remiss in failing to tell its members, other leaders in industry, and the public about much of its work. During the year the President and Secretary will develop specific proposals as to how this matter may be improved.

Organization of the Profession

The organization of the profession has been a matter of wide public discussion during the past few years. Certain steps now seem possible, and during the current year the Society should reach a conclusion as to practical steps which can be taken.

EUGENE W. O'BRIEN, *President*

A.S.M.E. President Honored

EUGENE W. O'BRIEN, president A.S.M.E., was elected an honorary member of the Georgia Engineering Society at its fifth annual meeting held at the Ansley Hotel, Atlanta, Ga., Jan. 17, 1947.

The certificate of honorary membership was presented to President O'Brien by Blake R. Van Leer, member A.S.M.E., president, Georgia Institute of Technology, Atlanta, Ga.

In his presentation remarks, Colonel Van Leer said: "When one has become president of The American Society of Mechanical Engineers, he is a person of acknowledged professional eminence. That he received the unanimous vote of our Board of Directors indicates he has the confidence of our membership.

"No man of my acquaintance has as many friends as Gene O'Brien. So, tonight, the Georgia Engineering Society welcomes you as distinguished engineer, educator, editor, public servant, and friend, into its small and select group of honorary members."

War-Devastated Libraries Need Technical Books

A NEW appeal to American engineers asking for idle technical books and publications or money for purchase of new books to help in the restoration of war-devastated libraries abroad has been made by the E.J.C. Book Commission.

A.S.M.E. members are urged to check their libraries for unwanted material. Send offers of books, containing lists by authors and title, or checks to Joseph Pope, chairman, E.J.C. Book Commission, 29 West 39th St., New York 18, N. Y.

PRESIDENT O'BRIEN (*right*) RECEIVES CERTIFICATE OF HONORARY MEMBERSHIP IN GEORGIA ENGINEERING SOCIETY FROM BLAKE R. VAN LEER (*left*)

Management Congress Set for Stockholm, Sweden, July 3 to 8, 1947

THE Eighth International Management Congress, originally planned for 1946, will be held in Stockholm, Sweden, July 3 to 8, 1947. William L. Batt, past-president and honorary member A.S.M.E., who is chairman of the International Committee of Scientific Management, will head the United States delegation.

World management Congresses have previously been held in Prague (1924), Brussels (1925), Rome (1927), Paris (1929), Amsterdam (1932), London (1935), and Washington (1938).

The 1947 Congress will be held against the background of the devastation and misery caused by the war and will endeavor to appraise the progress made in various fields of management since 1938.

The Congress will be opened officially with an address by Mr. Batt on "World Progress in Management Since 1938." Plenary sessions will be held on such themes as philosophy and application of scientific management, regional, and local planning in modern society, and the industrial relations and responsibilities of management and labor.

Sectional meetings are also planned on education for management, personnel, home management, and modern housing. Study tours have been arranged for the delegates. These will demonstrate Sweden's national resources, manufacturing and industrial working methods, and her solution of management problems in industry, agriculture, and the home.

John A. Willard, member A.S.M.E., chairman, National Management Council, is in charge of sponsoring the participation of the management bodies in the United States and the contribution of management papers for the Eighth International Management Congress.

The A.S.M.E. is a member body of the National Management Council which is an affiliate of the International Committee of Scientific Management.

A.S.M.E. 1947 Annual Meeting to Be Held in Atlantic City, N. J.

THE 68th Annual Meeting of The American Society of Mechanical Engineers will be held at the Chalfonte-Haddon Hall Hotels, Atlantic City, N. J., Dec. 1 to Dec. 5, 1947. This announcement was made at the meeting of the Executive Committee on Jan. 24. Only twice before in the history of the A.S.M.E. has an Annual Meeting been held away from New York, N. Y. The first time was in 1890 when the 11th Annual Meeting was held in Richmond, Va., and the second in 1939 when the 60th Annual Meeting was held in Philadelphia, Pa.

In 1948 the Society will again hold its Annual Meeting at the Pennsylvania Hotel, New York, N. Y.

The precedent-breaking decision to hold the Annual Meeting at a resort instead of an industrial center was influenced by the desire to avoid the hotel congestion in New York, expected to result from United Nations' meetings and to promote an atmosphere of sociability by accommodating more members in one hotel. The Council was also encouraged by the favorable reception given the idea of such a change by members who voted at the 1946 Annual Meeting.

The Society has been guaranteed 2700 rooms in the immediate vicinity of the Chalfonte-Haddon Hall, which are twin hotels. Members are asked not to write to the hotels for reservations because special arrangements are being set up for their convenience. All reservations are to be handled centrally by a Housing Bureau. When the plan has been organized, members will be given complete information on how to proceed with reservations.

1946 A.S.M.E. Annual Meeting Attendance

OFFICIAL attendance figures for the A.S.M.E. Annual Meeting held in New York, N. Y., Dec. 2 to 6, 1946, show an attendance of 5166. This is 11 per cent greater than the all-time record attendance of 4584 attained at the 1944 Annual Meeting and 37 per cent greater than the attendance in 1945.

Of those who participated in the 1946 meeting 56 per cent were members, 33 per cent were guests, 7 per cent students, and 4 per cent members of the Woman's Auxiliary.

In a geographical breakdown of attendance, the Metropolitan Section was first with 1651, Pennsylvania second with 732, New Jersey third with 676, and New York State fourth with 326. Connecticut, Massachusetts, and Ohio were each represented by more than 200 members and guests. California led the West Coast States with 27 representatives, and Georgia, with 31, led the states from the South.

Vannevar Bush Receives Hoover Medal

VANNEVAR BUSH, A.S.M.E. Holley Medalist, 1943, chairman of the newly created Joint Research and Development Board of the Army and Navy, received the Hoover Medal for 1946 "for outstanding public service" on Jan. 30, 1947, at the winter meeting of the American Institute of Electrical Engineers in the Engineering Societies Building, New York, N. Y.

The citation described Dr. Bush, wartime director of the Office of Scientific Research and Development, as the "engineer, educator, and administrator, who, in critical times of need, was in a most special sense an organizer, guiding spirit, and driving force of the nation's achievements in physical and medical science."

In his acceptance address, Dr. Bush declared that because of the achievements of research, "prospects vast and high lie before us," and that "through the voluntary collaboration of men of good will we have sure hope of attaining the betterment of life for all men throughout the world."

When free men join in voluntary collaboration, each contributing his skill "in the face of dire peril and sink their minor differences, the result is a controlled and concentrated strength that no opponent can withstand," he said.

Although the nation has gone far in establishing a pattern of relationship between government and science, Dr. Bush declared that "we have yet to learn the secret of perpetuating in the peace that mutual confidence and common endeavor which joined us in strong partnership against the forces of aggression."

Dr. Bush is the ninth man to receive the Hoover Medal, deemed one of the outstanding honors of the engineering profession. President Herbert Hoover was the first recipient, in 1930. The award is made by the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Civil Engineers, and The American Society of Mechanical Engineers to "a fellow engineer for distinguished public service."

Dr. Bush is president of Carnegie Institution of Washington and a member of the National Advisory Committee for Aeronautics. A graduate in electrical engineering from Tufts College in 1913, Dr. Bush holds honorary degrees from 12 colleges and universities. He invented a differential analyzer, one of the earlier of the huge "calculating brains," and is author of many technical papers. As head of wartime research, he directed activities which produced the atomic bomb and other new weapons, radar, lifesaving drugs like penicillin, blood substitutes, and treatments for malaria.

VANNEVAR BUSH, RECIPIENT OF HOOVER MEDAL FOR 1946

Wood Industries Plan National Conference

THE Wood Industries Division of The American Society of Mechanical Engineers will hold its 1947 National Conference in Madison, Wis., on June 12 and 13, 1947. This will be the first national conference held by the Division since 1938.

At a meeting of the Division's executive committee attended by C. B. Lundstrom, chairman, T. D. Perry, A. C. Fegel, C. R. Nichols, Jr., and F. F. Wangaard, the outline of the conference was discussed. The mornings of both days are to be given over to technical sessions with three papers each, while the afternoons are to be devoted to conferences at the Forest Products Laboratory, Madison, Wis. The main social function will be a dinner meeting with speakers and motion pictures and will be held Thursday evening, June 12.

Papers are planned on the following subjects: Tropical woods, fire-protection equipment, high-frequency heating equipment, accelerated test methods for ship timbers, molded plywood, and honeycomb constructions.

D. W. Nelson, professor, University of Wisconsin, Madison, Wis., and chairman, A.S.M.E. Rock River Section, is in charge of local arrangements.

N.I.C. to Continue to Serve Nation

THE National Inventors Council will continue to function as a screening agency for inventions relating to national security or problems of national significance, according to C. F. Kettering, member A.S.M.E., president, General Motors Research Corporation, and chairman of the Council.

Dr. Kettering announced that the Council has offered its services to review proposed inventions of possible value to the national welfare.

Many of the best ideas coming in to the Council today, Dr. Kettering said, are from returning veterans who have had personal experience with the military equipment now in use.

The National Inventors Council reviewed more than 300,000 inventions and ideas submitted to it during the war. All inventions believed to have merit were referred to the Army and Navy for final decision.

The Armed Forces "are seeking improvements in the design and performance of today's weapons. They will welcome ideas for new devices capable of rapid quantity production," the Council said.

The N.I.C. is composed of 16 leading scientists, engineers, and industrialists. These include Fred M. Zeder, member A.S.M.E., vice-chairman of the board, Chrysler Corporation, Detroit, Mich., and George W. Codrington, member A.S.M.E., general manager, Cleveland Diesel Engine Division, General Motors Corporation, Cleveland, Ohio.

Actions of the A.S.M.E. Executive Committee

At a Meeting Held at Headquarters, January 24, 1947

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, Jan. 24, 1947. There were present: Eugene W. O'Brien, chairman, J. N. Landis, vice-chairman, F. S. Blackall, Jr., A. C. Chick, A. R. Mumford, K. W. Jappe, treasurer, W. H. Sawyer, (Finance Committee), D. Robert Yarnall, past-president, C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

Resolution of Thanks

A resolution presented at the 1946 Annual Meeting to all members and committees who contributed to the success of the meeting was adopted as an expression of thanks and appreciation of the Society.

Future Meetings

Upon recommendation of the Meetings Committee, it was voted to hold the 1948 Fall Meeting in Portland, Ore., and the 1949 Fall Meeting in Erie, Pa.

A letter-ballot approval by the Council of holding the 1947 Annual Meeting in Atlantic City, N. J., and the 1948 Annual Meeting in New York, N. Y., was noted.

Secretaries of Professional Divisions

Approval of the appointment of the following secretaries of the executive committees of the Professional Divisions was confirmed:

Applied Mechanics, W. M. Murray; Fuels, C. E. Miller; Heat Transfer, A. C. Mueller;

Library Needs Back Issues of A.S.M.E. Publications

DO NOT throw away your back issues of A.S.M.E. publications. The Engineering Societies Library needs them.

Recently publishers and libraries abroad have been asking the Library for sets of back issues of A.S.M.E. publications, especially those published during the war, when normal exchanges were impossible. Although the Library has set aside many copies for exchange purposes the demand has exceeded the supply.

A.S.M.E. members are urged to check attics and cellars for idle copies which can be put to work in the university and industrial centers of the world.

Send war issues to Ralph H. Phelps, director, Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

Some prewar issues are also needed. Send your list to the Library for instructions.

Hydraulic, J. F. Roberts; Industrial Instruments and Regulators, P. G. Exline; Machine Design Group, G. F. Nordenholt; Management, Carlos deZafra; Metals Engineering, J. F. Young; Oil and Gas Power, C. F. Foell; Power, R. M. Van Duzer, Jr.; Process Industries, T. R. Olive; Production Engineering, Jesse Huckert; Railroad, E. L. Woodward; Rubber and Plastics, D. H. Cornell; Textile, R. O. Palmer; and Wood Industries, F. F. Wangaard.

1947 National Professional Division Meetings

Approval by the secretary of the following National Professional Division Meetings in 1947 was confirmed:

Oil and Gas Power, May 21–24, Cleveland, Ohio; Aviation, May 26–29, Los Angeles, Calif.; Wood Industries, June 12–13, Madison, Wis.; Applied Mechanics, June 19–21, or June 24–25, Schenectady or Saratoga Springs, N. Y.; Process Industries, October, Houston or Dallas, Texas; Fuels, October, Cincinnati, Ohio.

American Standards

Upon recommendation of the Standardization Committee, the following proposed revisions to American standards were approved as standards of the Society to be transmitted to the American Standards Association for approval as American Standards:

Slotted and Recessed Head Screws, B18c; and Socket Head Cap Screws and Socket Set Screws, B18.3.

Upon recommendation of the Standardization Committee, the following proposed standards were approved as standards of the Society to be transmitted to the American Standards Association for approval as American Standards:

Cast Iron Flanges and Flanged Fittings for Refrigerant Piping, 300 Lb, B16; and Supplement No. 2 to the American Standard Code for Pressure Piping, B31.

New Safety Code Proposed

Upon recommendation of the Safety Committee, a proposal to the American Standards Association for the organization of a sectional committee to develop a Safety Code for Industrial Power Trucks was authorized. The Society would serve as sponsor or joint sponsor for the project.

Consulting Engineering Group

It was voted to disband the Consulting Engineering Group and to set up committees to carry on the projects of the group under supervision of the Board of Education and Professional Status.

"Applied Mechanics Reviews"

For purposes of the proposed publication, *Applied Mechanics Reviews*, the Committee approved the creation of an Advisory Board with the following function: "To advise the Council of A.S.M.E., the Managing Committee, or the editor of *Applied Mechanics Reviews* on policies and procedures for the operation" of the proposed publication.

The Advisory Committee consists of one representative of each of the following societies: The American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Physics, American Mathematical Society, Institute of Aeronautical Sciences, and the Society for Experimental Stress Analysis. The A.S.M.E. representative on the Board, who was appointed by the Applied Mechanics Division, is R. E. Peterson.

Mr. Peterson was elected chairman of the Advisory Board at its first meeting.

Presidential Program

The program of objectives for the 1946–1947 Council outlined by the President was approved. The program is published on pages 249 and 250 of this issue.

Nuclear-Energy Terms

Upon recommendation of the Nuclear Energy Application Committee, a loan was voted to the Committee for issuance of a glossary of common terms and definitions of importance to nuclear-energy engineering.

New Labor Legislation

Upon recommendation of the Engineers Joint Council that the Founder Societies create a panel to further new labor legislation, the Committee appointed Walter S. Finlay, Jr., fellow A.S.M.E., vice-president, J. G. White Engineering Corporation, New York, N. Y., to serve as A.S.M.E. representative on the proposed panel.

The following general principles on labor policy were adopted:

(1) No professional employee or group of employees, desiring to undertake collective bargaining with an employer, should be forced to affiliate with or accept membership in any bargaining unit which includes nonprofessional employees, or to submit to representation of such group or its designated agents.

(2) No professional employee should be forced against his desire to join any bargaining unit or other organization as a condition to his employment or to sacrifice his right to individual personal relations with his employer in the matter of employment conditions.

(3) However, nothing in the foregoing declarations of policy shall be construed as depriving any group of professional employees who have a community of interest and who wish to bargain collectively of the right to form and administer their own bargaining unit or of the right of free choice of their representatives to negotiate with their employer.

World Engineering Conference

Upon recommendation of the Engineers Joint Council, it was voted to authorize participation in and co-operation with the World Engineering Conference, organized at the International Technical Congress in Paris, September, 1946.

E.J.C. Committee on International Relations

Upon recommendation of the Engineers Joint Council that each constituent society designate one member of its Council as a member of the E.J.C. Committee on International Relations, the Committee authorized the president to appoint a member of the Council to serve on the E.J.C. Committee for a term not to exceed two years.

Study of Bloom Bill

On suggestion of the Engineers Joint Council it was voted to appoint an A.S.M.E. representative to co-operate with representatives of the American Society of Civil Engineers in the drafting of legislation that may be introduced in the Eightieth Congress to fulfill the purposes served by HR 4982, Bloom Bill, which died with the last Congress. The Bloom Bill concerned government policy of rendering consulting engineering service by government departments to foreign governments.

Use of Engineering Skills During World War II

In accordance with the desire of the War Department's Division of Research and Development for a survey of the use to which engineering skills were put during World War II, the Committee voted to submit a questionnaire to each A.S.M.E. member similar to the one already issued for the same purpose by the American Chemical Society, provided it is satisfactory to the War Department and provided it will be tabulated in suitable form for the War and Navy Departments.

Appointments

The Committee confirmed the appointments of President Eugene W. O'Brien, Arthur L. Brown, and Albert C. Wood as A.S.M.E. representatives to the Hotel Fire Safety Conference held in Philadelphia, Pa., Jan. 16, 1947.

The acceptance by John P. Magos of an appointment to serve five years on the Research Committee was noted.

[A complete list of A.S.M.E. Committee personnel can be found in the Society Records Section of the February issue of the *Transactions*, copy of which may be obtained by writing to headquarters.]

Engineering Foundation Asks Bequests to Aid Research

A. B. KINZEL, chairman of The Engineering Foundation, Engineering Societies Building, New York, N. Y., has announced that in view of the postwar increase in opportunities for productive research in the field of engineering, the Foundation would welcome bequests and gifts to supplement its current principal fund of about $1,000,000.

The Foundation has been engaged in important research activities for more than 30 years. It was created by the four Founder Societies in the engineering field—American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and American Institute of Electrical Engineers.

The Foundation is a department of the United Engineering Trustees, Inc., a nonprofit organization exempt from Federal income tax. Contributions made to the United Engineering Trustees, Inc., for the Engineering Foundation Fund are deductible for Federal income-tax purposes to the extent provided by the Act. The Foundation is administered by a Board of 16 members, including men outstanding in the engineering profession, research, business, and education.

Inquiries about gifts and bequests may be directed to John H. R. Arms, secretary of the Engineering Foundation, Engineering Societies Building, 29 West 39th Street, New York 18, N. Y.

Karl T. Compton Receives Washington Award

KARL T. COMPTON, member A.S.M.E., and president, Massachusetts Institute of Technology, Cambridge, Mass., received the Washington Award of the Western Society of Engineers at a dinner meeting of the W.S.E. in the Continental Hotel, Chicago, Ill., on Feb. 26, 1947. Dr. Compton was selected for the award because of his scientific and engineering activities which have contributed to the happiness, comfort, and well-being of humanity.

The Washington Award is conferred each year by the Western Society of Engineers on the recommendation of a commission of award composed of representatives of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Western Society of Engineers.

J. R. Michel and R. E. Turner are the A.S.M.E. representatives on the W.E.S. board of award.

A.S.R.E. Secretary Resigns

THE resignation of David L. Fiske as secretary of The American Society of Refrigerating Engineers, an office he held since 1927, has been announced. Mr. Fiske plans to undertake consulting and other activities in the field of market research in refrigeration.

A.S.M.E. Membership Passes 22,000 Mark in 1946

WITH the election of James E. Clipperton, Trinidad, B.W.I., membership in The American Society of Mechanical Engineers passed the 22,000 mark in December, 1946. The rate of increase of 1000 members per year established in 1940 has continued through 1946 and the applications received in the first two months of 1947 indicate that the rate continues.

Membership in the Society seems to follow the curve of business cycles. During the depression of the 1930's, membership dropped from a high of 20,000 in 1933 to 14,000 in 1934. Six years later the membership was still under the 15,000 mark. In 1940, however, a sudden change occurred. Since then membership applications have increased rapidly and new members have been elected at a rate of more than 1000 per year, and last year approximately 2000 were added to the ranks.

Several other factors besides the economic one seem to be responsible for the sustained interest in Society membership. Engineers who were formerly satisfied to practice their profession without any tangible evidence of professional recognition seem eager to identify themselves with professional activities. The engineering achievements of the war have given recognition to engineers and this prestige has fostered a professional consciousness among engineers. Young veterans, too, taking advantage of the G.I. Bill of Rights, are crowding engineering schools and casting their lot with the engineering profession. Eager for training, they are taking part in student-branch activities and joining the Society for the professional opportunities offered.

The A.S.M.E. has rigid requirements for various grades of membership and tries to discourage ill-considered applications. The A.S.M.E. Admissions Committee reviews carefully the qualifications of each applicant and confirms statements of experience. This procedure is time-consuming and often takes three months or more before election of an applicant can be announced.

Because many mechanical engineers of high professional attainment are not members, the Society maintains a Membership Development Committee. To aid Sections and Professional Divisions in membership development, this committee has issued a Membership Development Guide, copy of which may be obtained from headquarters.

W. M. Sheehan, fellow A.S.M.E., vice-president, General Steel Casting Corporation, Eddystone, Pa., has, through his personal efforts, encouraged 90 engineers to submit applications. D. O. Barrett, chairman, A.S.M.E. Mid-Continent Section, chief mechanical engineer, Gulf Oil Corporation, Tulsa, Okla., has 18 memberships to his credit.

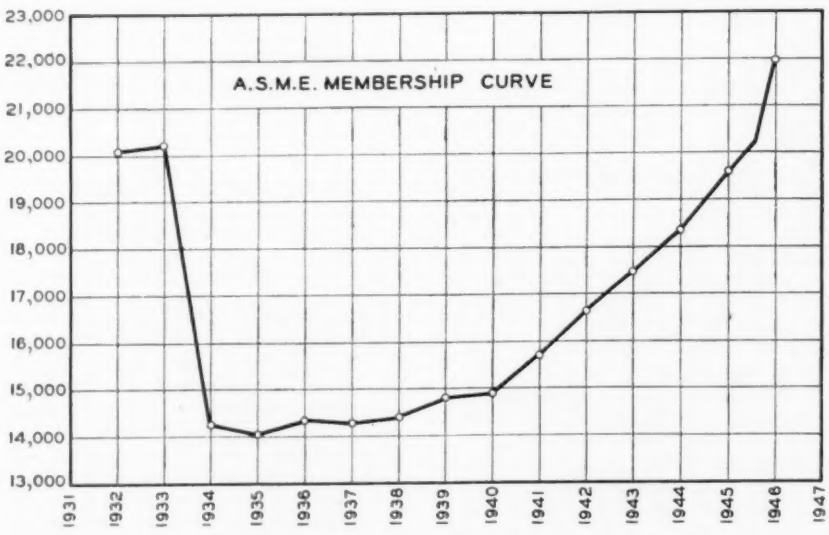
The rise in Society membership can also be attributed to the active program in membership development carried on by various A.S.M.E. Sections. The Chicago Section, Southern California Section, Philadelphia Section, and the San Francisco Section have been especially active during 1946.

1947 N.F.P.A. Electrical Code Available

THE National Fire Protection Association has announced the publication of the 1947 edition of the National Electrical Code, a 408-page volume dedicated to the prevention of electrical fires and accidents.

The code specifies the exact manner in which electrical materials, devices, fittings, and appliances should be installed and maintained.

The code sells for $2 per copy and may be obtained from the National Fire Protection Association, 60 Batterymarch Street, Boston 10, Mass.



THIS IS WHAT HAPPENED TO A.S.M.E. MEMBERSHIP DURING THE PAST 14 YEARS

Fritz Medal Presented to L. W. Chubb

THE John Fritz Medal for notable scientific and industrial achievements during 1946 was presented to Lewis W. Chubb, director, Westinghouse Research Laboratories, East Pittsburgh, Pa., on Jan. 29, 1947, at the annual winter meeting of the American Institute of Electrical Engineers in the Engineering Societies Building, New York, N. Y.

The citation accompanying the award read: "For pioneering genius and notable achievements during a long career devoted to the scientific advancement of the production and utilization of electric energy."

The medal presentation was made by Nevin E. Funk, vice-president, A.S.M.E. Region III, and chairman of the Board of Award. The presentation address was made by Marvin W. Smith, vice-president in charge of engineering, Westinghouse Electric Corporation, Pittsburgh, Pa. Malcolm Pirnie, of New York, presided at the ceremonies.

The John Fritz Medal is awarded jointly each year by the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Civil Engineers, and The American Society of Mechanical Engineers. The medal was first presented in 1902 to John Fritz and has since been awarded to such men as Alexander Graham Bell, Thomas A. Edison, George W. Goethals, Orville Wright, and Herbert Hoover.

Director of the Westinghouse Research Laboratories since 1930, Dr. Chubb developed the technique of electrostatic or magnetic welding for joining dissimilar metals without creating brittle alloys—the technique used to weld stainless steel and aluminum for streamlined trains. He also pioneered in experiments to polarize automobile headlights, cutting down on blinding headlight glare at night.

LEWIS W. CHUBB (*left*) RECEIVES THE JOHN FRITZ MEDAL FROM N. E. FUNK, (*right*) VICE-PRESIDENT A.S.M.E. REGION III, AT THE WINTER CONVENTION OF THE A.I.E.E.

A.S.M.E. Calendar

of Coming Events

March 2–5, 1947
A.S.M.E. Spring Meeting
Tulsa, Okla.

May 21–24, 1947
A.S.M.E. Oil and Gas Power Division Meeting
Cleveland, Ohio

May 26–29, 1947
A.S.M.E. Aviation Division Meeting
Los Angeles, Calif.

June 12–13, 1947
A.S.M.E. Wood Industries Division Meeting
Madison, Wis.

June 16–19, 1947
A.S.M.E. Semi-Annual Meeting
Chicago, Ill.

June 23–25, 1947
A.S.M.E. Applied Mechanics Division Meeting
Schenectady, N. Y.

Sept. 1–4, 1947
A.S.M.E. Fall Meeting
Salt Lake City, Utah

Sept. 8–9, 1947
A.S.M.E. Instruments and Regulators Division Meeting
Chicago, Ill.

Oct. 6–8, 1947
Petroleum Committee of the A.S.M.E. Process Industries Division Meeting
Houston, Texas

Oct. 20–22, 1947
A.S.M.E. Fuels Division Meeting
Cincinnati, Ohio

Dec. 1–5, 1947
A.S.M.E. Annual Meeting
Atlantic City, N. J.

Translation of Flow-Measurement Papers Available

TWO papers on flow measurement originally published in Europe have been translated into English for the A.S.M.E. Special Research Committee on Fluid Meters and have been deposited in the Engineering Societies Library, New York, N. Y., and the Carnegie Library, Pittsburgh, Pa., where they are now available to engineers for consultation. These papers are:

The Viscosity of Gases, Its Determination, and Its Signification in Flow Measurement, by Walter Ruppert, Hydro-Apparate-Bauanstalt, Düsseldorf, Germany.

Standardized Nozzles and Orifices Used in Closed Conduits; Results of Experiments at Low Reynolds Numbers, by Mario Marchetti, Reale Istituto Superiore d'Ingegneria, Milan, Italy.

As a service to engineers, the Engineering Societies Library has on hand more than 7000 translations of foreign technical papers. These are available for consultation without charge. A small service fee is charged for photocopying.

International Technical Congress Proceedings Available

THE Proceedings of the International Technical Congress held in Paris, September, 1946, may now be obtained from the A.S.M.E. The Proceedings consist of 130 papers by authors from 14 countries. Twenty-six of the papers deal with general engineering problems of reconstruction, one with nuclear energy, and 79 discuss the present situation of engineering, interdependence of various branches of the engineering profession, future trends, and relations of engineering developments among the nations. Twenty-two others give consideration to the professional and economic status of the engineer.

Forty-four papers are written in English. English and French synopses are provided with papers in other languages.

Price of the set is $20 and may be obtained from The American Society of Mechanical Engineers, Publication Sales, 29 West 39th St., New York 18, N. Y.

A.S.M.E. Reprints British Gas-Turbine Lectures

AS a service to American engineers, The American Society of Mechanical Engineers has reprinted for distribution in the United States twelve lectures presented before The Institution of Mechanical Engineers on "The Development of the British Gas Turbine Jet Unit."

The volume, containing 103 pages of text and 32 plates of photographs, provides a first-hand account of the basic work that has been done on the problems of the gas turbine.

The first lecture deals with the history of the axial compressor and the axial-type turbine engine in Great Britain. Other lectures cover the design and development of centrifugal compressors for aircraft turbines, fluid dynamic theory for compressors, data for estimating performance and design of compressors. Vibration problems and recent developments in high-temperature materials of gas turbines are also discussed.

The volume sells for $3 per copy and may be obtained from The American Society of Mechanical Engineers, Publication Sales, 29 West 39th St., New York 18, N. Y.

Correction

THE A.S.M.E. Fuels Division Meeting will be held in Cincinnati, Ohio, Oct. 20–22, 1947. The date and place of this meeting was incorrectly listed in the "A.S.M.E. Calendar of Coming Events" published in the February issue.

John E. Younger Honored

PRESENT and former members of the executive committee of the A.S.M.E. Aviation Division met for dinner at the Engineers Club, New York, N. Y., on the evening of Jan. 23, 1947, to honor Dr. John E. Younger, until recently chairman of the department of mechanical engineering, University of Maryland, College Park, Md.

For the last four years Professor Younger has served as the executive secretary of the Aviation Division, a post which he is relinquishing owing to the fact that he has been engaged by the Brazilian Government to advise on the organization of educational programs in aviation in Brazil.

Dr. Younger was awarded the Spirit of St. Louis Medal in 1941 "for notable contributions to the science of airplane design, particularly in the conception, analysis, and supervision of the development of the fundamental design principles, requirements, and criteria which first insured success of the pressure-cabin type of high-altitude airplane."

Before assuming his post at the University of Maryland, Dr. Younger served at the University of California, from which he has received the degrees of B.S., M.S., and Ph.D. Many prominent aeronautical engineers and designers have been students in his courses.

At the dinner meeting on January 23, Dr. Younger was given a framed certificate signed by the President and Secretary of A.S.M.E. and members of the executive committee of the Aviation Division. In presenting the certificate, R. P. Kroon, chairman of the Division, recalled that Dr. Younger had been engaged as executive secretary of the Division at a time when constant attention to the program of the Division was essential. The growth and progress of the Division had been greatly aided by Dr. Younger's work on its behalf. Among other accomplishments was the organization of the Aviation meetings, held annually at Los Angeles, which have been extremely popular and have attracted large audiences.

STEVENS HOTEL, CHICAGO, ILL., HEADQUARTERS FOR A.S.M.E. 1947 SEMI-ANNUAL MEETING

Present at the dinner, in addition to Dr. Younger and Mr. Kroon, were F. K. Teichmann, Herman Hollerith, E. S. Thompson, and E. Kenneth Salisbury, of the executive committee; Charles H. Dolan II, E. E. Aldrin, and James M. Clark, associates; R. G. Standerwick, of the general committee; Franklin H. Fowler, Jr., junior adviser; John Delmonte, representative of the Rubber and Plastics Division; and Ernest Hartford, O. B. Schier, II, and George A. Stetson, of the A.S.M.E. staff.

During the evening, E. W. O'Brien, president A.S.M.E., Harold V. Coes, past-president, N. E. Funk, vice-president, Region III, and C. E. Davies, secretary A.S.M.E., dropped in to offer congratulations to Dr. Younger.

Chicago Section Plans Full Social Program for A.S.M.E. 1947 Semi-Annual Meeting to Be Held in Chicago, Ill., June 16–19

MORE than 50 Chicago Section members are actively engaged on all phases of the plans for the A.S.M.E. 1947 Semi-Annual Meeting to be held at the Stevens Hotel, Chicago, Ill., June 16-19, 1947. Committee chairmen include John R. Michel, general committee chairman, and Robert H. Bacon, vice-chairman; Oliver F. Campbell, technical sessions committee; Arthur B. Openshaw, entertainment committee; John P. Magos, inspection-trips committee; Vernon G. Leach, registration committee; W. T. McCullough, reception committee; B. H. Jennings, student-group committee; S. E. Winston, hotel committee; Howard F. Lane, print and signs committee; Mrs. A. B. Openshaw, women's committee; and C. C. Austin, publicity committee.

At the Hotel Stevens 750 rooms have been set aside for A.S.M.E. members and their guests. Special emphasis, however, is placed on Sunday arrival so the committee is planning an important affair for Sunday afternoon, June 15.

Members of the Chicago Section will provide a hundred or more automobiles and will drive the visiting members and their guests on a trip along the lake front up to Wilmette. The entire facilities of the beautiful Michigan Shores Club at Wilmette will be made available to the A.S.M.E. and there will be a reception with refreshments, Sunday evening supper, and an entertaining program.

On Monday morning the technical sessions will begin and for the next four days there will be a wealth of information presented at some 30 or more sessions. On each of the days there will be a luncheon with an outstanding speaker, and two big dinners are also planned. The first of these dinners on Monday evening will be in the nature of a get-together. A very fine vaudeville program will be presented before and during the dinner and then the management group will sponsor a most unusual program with two nationally known speakers. The women are invited and will find this affair of unusual interest. On Wednesday night the Banquet in the Grand Ball Room at the Stevens will feature an eminent speaker whose subject will be enjoyed by both women and men. With 1600 places available in one of the most beautiful banquet rooms in the world it is planned to make this a memorable affair in both magnitude and interest.

The Inspection Trip Committee has already lined up a number of trips to see plants of outstanding interest. In practically all cases these plants have not been receiving visitors because of war activities. Now back to full peacetime production and with all the latest developments in engineering practice in full swing, these plants should attract a large number of A.S.M.E. visitors.

The Woman's Auxiliary of the Chicago Section is also at work on a wide range of activities for the women. There will be shopping expeditions, sight-seeing trips, and luncheons.

Hearings in Houston and Los Angeles Planned by Boiler Code Committee

FOR convenience of engineers in the Southwest and on the West Coast, the A.S.M.E. Boiler Code Committee plans to hold public hearings on the proposed revision of the A.S.M.E. Unfired Pressure Vessel Code, Section VIII of the A.S.M.E. Boiler Construction Code, in Houston, Texas, on May 1 and 2, 1947, and in Los Angeles, Calif., on May 7, 1947.

Traveling in a group the Committee will stop off at Houston for the hearings, then continue on to Los Angeles where it will hold its regular meeting and a public hearing on the proposed revision.

E. R. Fish, chairman, A.S.M.E. Special Committee to Revise Section VIII, will preside at the hearings. H. B. Oatley, chairman, A.S.M.E. Boiler Code Committee, will preside at the regular Committee meetings.

The purpose of the hearings is to give engineers in the South and West who are interested in the A.S.M.E. Unfired Pressure Code an opportunity to express personally their views on the proposed revision and thereby to participate directly in the work of the revision.

All engineers interested in the work of the Boiler Code Committee are invited to attend. Copies of the Proposed Revision of Section VIII are available in draft form and may be obtained from the A.S.M.E., 29 West 39th St., New York 18, N. Y. for $1 per copy.

While in Los Angeles, the Committee will attend the 1947 General Meeting of the National Board of Boiler and Pressure Vessel Inspectors, which is to be held in the Biltmore Hotel, May 5 and 6, 1947. This meeting will be devoted to discussions of the administrative phases of boiler and unfired-pressure-vessel safety regulations. The membership of the National Board is composed of the chief boiler inspectors of those states and cities in the United States and of the provinces of Canada which have adopted the A.S.M.E. Boiler Construction Code.

Meetings and Expositions of Other Societies

March 17–22
American Institute of Mining and Metallurgical Engineers, 75th Anniversary Celebration and Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

March 19–22
American Society of Tool Engineers, Annual Meeting, Rice Hotel, Houston, Texas

March 21–22
The Society for the Advancement of Management, Statesmanship in Management Meeting, Ambassadore Hotel, Los Angeles, Calif.

March 22–27
American Welding Society, District Meeting in conjunction with Western Metal Congress, Oakland, Calif.

March 22–27
American Society for Metals, Western Metal Congress and Exposition, Oakland, Calif.

March 25–28
Greater New York Safety Council, 17th Annual Safety Convention and Exposition, Hotel Pennsylvania, New York, N. Y.

April 8–11
American Management Association, Packaging Meeting and Exposition, Convention Hall, Philadelphia, Pa.

April 9–11
Society of Automotive Engineers, Aeronautic Meeting, Hotel New Yorker, New York, N. Y.

April 14–18
American Chemical Society, 111th National Meeting, Hotel Traymore and Convention Hall, Atlantic City, N. J.

April 16–18
Society of Automotive Engineers, Transportation Meeting, Hotel Stevens, Chicago, Ill.

April 18–19
The Society for the Advancement of Management, Time Study and Methods Meeting, Hotel Pennsylvania, New York, N. Y.

April 21–22
American Management Association, Production Meeting, Hotel New Yorker, New York, N. Y.

April 21–23
American Institute of Mining and Metallurgical Engineers, National Open Hearth and Blast Furnace Meeting, Netherland Plaza Hotel, Cincinnati, Ohio

May 11–13
American Institute of Chemical Engineers, St. Louis Meeting, Hotel Coronado, St. Louis, Mo.

19th Oil and Gas Power Conference Planned for Cleveland, Ohio

ARRANGEMENTS are being completed for the 19th Annual Conference of the Oil and Gas Power Division of the A.S.M.E., scheduled for Cleveland, Ohio, on May 21–24, 1947. The Hotel Statler will serve as the Conference headquarters.

Registration will take place on the morning of opening day, Wednesday, May 21. Thereafter, technical sessions are planned on the following subjects: Fuel supplies for internal-combustion prime movers (liquids, commercial gases, by-product gases); bearings (types, features, performance); European developments in internal-combustion machinery; fundamentals of combustion; and routine use of the pressure indicator.

Ample time is to be allowed for plant inspection trips in order that visitors may take full opportunity of the possibilities of a city such as Cleveland, which has a wide diversity of industrial interests. The social aspects of the Conference center about the dinner, planned for Thursday, May 22, a number of social hours, and an informal evening get-together of the kind famous in conference history.

Manufacturers' exhibits will play a prominent part. Advance interest in this educational feature, which has grown in scope and value year after year, indicates that manufacturers of engines and related equipment will display a greater variety of items than ever before. J. M. Clark, A.S.M.E. staff, has been appointed exhibit secretary and will handle all details pertaining to exhibits.

Pending announcement of final details, it is urged that those planning to attend the Conference make room reservations promptly with Hotel Statler, prior to May 1, 1947.

George Codrington, member A.S.M.E., Cleveland industrialist and manager, Cleveland Diesel Engine Division, General Motors Corporation, is honorary chairman. Heading the over-all committee is Lee Schneitter, chairman, A.S.M.E. Oil and Gas Power Division. Others on the general committee are: L. N. Rowley, Jr., chairman, Meetings and Papers Committee; C. F. Foell, secretary, Oil and Gas Power Division; P. B. Jackson, associate, executive committee, O.G.P. Division, and Edward Crankshaw, chairman, A.S.M.E. Cleveland Section.

Course in Dry-Kiln Practice Planned

A COURSE in dry-kiln practice for engineers and supervisors in the wood industries will be given at The New York State College of Forestry, Syracuse University, Syracuse, N. Y., March 24 to April 22, 1947.

The course consists of lectures, demonstrations, classroom and round-table discussions on various phases of drying lumber.

The fee is $50. Communications should be addressed to Extension Department, New York State College of Forestry, Syracuse 10, N. Y.

E.I.C. Inaugurates Scholarship Fund

A $25,000 scholarship fund has been inaugurated by The Engineering Institute of Canada to help students on the university level to complete their engineering and scientific education. Canadian engineers are being encouraged to support the fund by donations and endowments as an opportunity and an obligation of the engineering profession to aid needy students who show talent.

The fund is known as the "Harry F. Bennett Educational Fund of The Engineering Institute of Canada" in memory of the late Harry F. Bennett who did much to carry the Institutes, influence and assistance to Canadian high schools and engineering students. American members will remember the late Mr. Bennett as the Canadian engineer who for many years was active on the E.C.P.D. Committee on Student Selection and Guidance.

Four Americans Elected to International Committee

FOUR A.S.M.E. members and Fellows were elected to represent the scientists and engineers of the United States on the International Committee which is charged with the task of organizing participation in the next International Congress for Applied Mechanics scheduled for 1950.

They are J. C. Hunsaker, honorary member A.S.M.E., Massachusetts Institute of Technology, Cambridge, Mass.; Theodor von Kármán, member A.S.M.E., A.S.M.E. Medalist, 1941, California Institute of Technology, Pasadena, Calif.; Stephen P. Timoshenko, fellow A.S.M.E., Worcester Reed Warner Medalist, 1935, Stanford University, Stanford University, Calif.; and Hugh L. Dryden, member A.S.M.E., National Bureau of Standards.

The International Committee is the managing body of the International Congress for Applied Mechanics. It concerns itself with international co-operation and advancement and standardization of the sciences of applied mechanics.

At the Sixth International Congress held at the Sorbonne, Paris, September, 1946, the International Committee approved the formation of an International Union of Applied Mechanics to be affiliated with the International Council of Scientific Unions.

Engineering Fellowships Announced

A NUMBER of fellowships, scholarships, and assistantships in science and engineering for the term beginning Sept. 22, 1947, have been announced by the Illinois Institute of Technology, Chicago, Ill.

Among the fellowships are the Universal Oil Products Fellowship in Chemistry; the Westinghouse Educational Foundation Fellowship in power-systems engineering; and others.

For additional information write to Dean of the Graduate School, Illinois Institute of Technology, 3300 Federal Street, Chicago 8, Ill.

Many A.S.M.E. Members to Participate in Midwest Power Conference

POWER, its production, transmission, and consumption, with the current problems and the recent development of each phase, will be discussed at the Midwest Power Conference to be held at the Palmer House, Chicago, Ill., March 31 to April 2, 1947.

The conference is sponsored by the Illinois Institute of Technology, Chicago, Ill., with the co-operation of nine Midwestern universities and eight Midwestern engineering societies. Stanton E. Winston, member A.S.M.E., will direct the conference for the eighth time. The A.S.M.E. Chicago Section is one of the co-operating bodies.

Besides sponsoring the opening luncheon, the A.S.M.E. Chicago Section is arranging a technical session on central-station practice.

The following papers by A.S.M.E. members will be presented at various sessions of the conference:

Central-Station Combustion-Control Problems, by C. H. Smoot, Republic Flow Meters Company, Chicago, Ill.

Inspection for Safety Power-Plant Equipment, by Wm. D. Halsey, chief engineer, boiler division, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

Losses in the Cycle of a Heat Pump Using a Ground Coil, by R. A. Budenholzer, Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill..

Diesel Developments of Significance, by C. G. A. Rosen, director of research, Caterpillar Tractor Company, Peoria, Ill.

The Performance of the Diesel Locomotive, by A. G. Hoppe, Chicago, Milwaukee, St. Paul and Pacific R. R. Company, Milwaukee, Wis.

Energy Sources of Tomorrow, by Ralph A. Sherman, Battelle Memorial Institute, Columbus, Ohio.

Methods of Firing Pulverized Coal, by Otto de Lorenzi, Combustion Engineering Company, New York, N. Y.

Power for the Paper Industry, by Robert Krause, Container Corporation of America, Chicago, Ill.

Metallurgical Considerations in H.T.-H.P. Piping Layouts, by J. J. Kantor, Crane Company, Chicago, Ill.

Materials as a Consideration in Modern Boiler-Feed-Pump Construction, by Hugh Ross, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Increasing the Engineers' Contribution to Civic Progress, by R. M. Gates, past-president and fellow A.S.M.E.; president, Air Preheater Corporation, New York, N. Y.

Where Will the Gas Turbine Fit as a Stationary Power Plant? by L. N. Rowley, Jr., managing editor, and B. G. A. Skrotski, associate editor, *Power*, McGraw-Hill Publishing Company, New York, N. Y.

Recent Gas-Turbine Developments at Brown Boveri, by Paul B. Sidler, president, Brown Boveri Corporation, New York, N. Y.

The Coal-Burning Gas-Turbine Power Plant, by John I. Yellott, director of research, Locomotive Development Committee, Baltimore, Md.

ERIK OBERG, MEMBER A.S.M.E.

Erik Oberg Tours Europe as Guest of U. S. Army

ERIK OBERG, member A.S.M.E., secretary, The Industrial Press, and former editor, *Machinery*, was the only engineer among a party of 12 newspaper and radio editors who flew to Europe on Jan. 15, 1947, for a 30-day tour of inspection as guests of the U. S. Army. Mr. Oberg and the editors visited Italy, Austria, Germany, and France to observe what the military government had done since termination of hostilities.

Before leaving the country the party were guests of Secretary of War Patterson in Washington, D. C. Upon arrival in Rome, they were received by the Pope.

Mr. Oberg has been active in the affairs of The American Society of Mechanical Engineers for many years. He served the Society as treasurer from 1925 to 1935. Currently he is serving as chairman of the Advisory Committee for Metal Cutting Data, new Society publication.

On the occasion of his retirement as editor of *Machinery* and the 40th anniversary of his affiliation with The Industrial Press, Mr. Oberg was honored by his business associates who presented him with a scroll expressing their admiration and esteem and a silver tray in token of his services. He received many congratulatory messages from officers and friends in the A.S.M.E.

C. O. Herb, member A.S.M.E., has succeeded Mr. Oberg as editor of *Machinery*.

Library Service Bureau Increases Rates

AN increase in rates for such services as searches, translations, and photostatic and microfilm copies of library material provided by the Service Bureau of the Engineering Societies Library, Engineering Societies Building, New York, N. Y., has been announced. These services are provided at cost but under the prewar rates the Bureau has been operating at a loss.

The rates were increased as follows: Searches, from $2.50 per hour to $3; translations from German, French, Italian, and Spanish to English from $1 per hundred words to $1.50 per hundred words; translations from Russian, Polish, Dutch, Portuguese, Danish, Swedish, etc., to English from $1.20 per hundred words to $2 per hundred words. The rate for the translation of Japanese, Chinese, etc., remains the same at $3 per hundred words.

A 20 per cent discount is granted to A.S.M.E. members who order work for personal use or who pay by personal check.

Metropolitan Junior Members Undertake Comprehensive Study of Engineer and Union Problem

JUNIOR members of the A.S.M.E. Metropolitan Section have initiated a planned study of the impact of unionism on the engineering profession and hope to draft a statement expressing how they feel about unions and what action they would like to have the Society take to protect their interest.

Encouraged by President O'Brien at the 1946 Annual Meeting and supported financially by the Executive Committee of the A.S.M.E. Metropolitan Section, the Junior Group Committee on Professional Status Development organized a forum on Jan. 15, 1947, at which the problems of the unions were discussed by A.S.M.E. members, union agents, and engineers of other professional bodies. Another forum is planned for May, 1947, at which the draft statement will be discussed.

In outlining Committee objectives, John H. Prentiss, chairman, declared: "In undertaking this task as a junior-member effort, we do so without any intention to encourage a union for engineers. We feel keenly the responsibility which falls to us by virtue of our experience and knowledge of the aggression by nonprofessional bodies on the lower echelons of the profession. We hope our efforts will help."

The first forum on the Union question was sponsored by the A.S.M.E. Metropolitan Section in November, 1946. D. Robert Yarnall, past-president A.S.M.E., spoke on "Organization of the Engineering Profession," and C. W. Ransom, chairman, National Societies Committee, General Electric Employees Association, was the main discusser. The general discussion which followed extended late into the night.

Encouraged by this show of interest, the Junior Group Committee sponsored a second forum in January, 1947. Following carefully planned agenda, the forum discussed, in turn, the advantages and disadvantages of unions, methods of union organization, current programs of various professional societies, and suggestions for a future plan of action which

could be taken by the Society. The entire meeting was recorded on disks.

As the result of the large number of junior members who volunteered their services, the Committee expanded and set up 5 subcommittees to analyze the vast fund of information provided by the two forums.

Not content with a superficial analysis of opinions, the Committee is currently making a detailed study of the literature on unionism, as it relates to the professions; also labor laws and case histories of union-engineer conflicts.

According to Mr. Prentiss, the Committee will welcome correspondence from groups in other Sections who are working or planning to work on this problem. He offers an interchange of information and will provide data that has been secured by the Metropolitan Junior Group.

Correspondence should be addressed to the Junior Group Committee on Professional Status Development, A.S.M.E. Metropolitan Section, 29 West 39th St., New York 18, N. Y.

Sections

Akron-Canton Section Hears Talk on Jet Propulsion

At the Y.W.C.A., Akron, Ohio, on Jan. 16, a meeting was held which featured Charles L. Fay, Bell Aircraft Corporation. Mr. Fay's talk on "Jet Propulsion" covered a complete history of the jet engine from its conception in England; the first unit made in this country by the combined efforts of the General Electric Corporation and the Bell Aircraft Corporation; laboratory tests, first flight, and production setup. He also described the helicopter and its commercial uses. Both subjects were illustrated by sound movies in color. The meeting concluded with an open discussion. Dr. Karl Arnstein, vice-president, Goodyear Aircraft, was present. The audience numbered 112.

Electronic Potentiometers Subject at Boston Section

A meeting was held on Jan. 23 at Northeastern University, Boston, Mass., with 110 present. Walter Wills, development engineer, Brown Instrument Division, spoke on "Electronic Potentiometers as Applied to Temperature Measurements." Mr. Wills explained the principles of operation of the electronic potentiometer as applied to temperature measurements. He described the older galvanometer types and showed clearly the steps in the development of the electronic types.

Central Iowa Section Hears Talk on Oil-Well Perforator

On Jan. 21 at Iowa State College, Ames, Iowa, before an audience of 250, W. G. Lane spoke on "Development, Construction, and Use of the Lane-Wells Oil-Well Perforator." The speaker described the development and use of the oil-well-casing perforating gun of which he was the coinventor. He listed the problems involved and the difficulties encountered in the development of the gun and described the way these difficulties were overcome. Mr. Lane also showed motion pictures of the use of the gun on location.

Cincinnati Section Meets With A.S.M. and Engineering Society of Cincinnati

On Dec. 12 in the Engineering Societies Building, Cincinnati, Ohio, a joint meeting was held with the A.S.M. and the Engineering Society of Cincinnati. An audience of over 200 heard H. J. Clyman, assistant to manager, engineering department, aviation-gas-turbine division, Westinghouse Electric Corporation, speak on "The Aviation Gas Turbine of Today and Tomorrow." The speaker told of some experiences of American designers of gas turbines and of turbojet aviation engines. He showed slides of some models and gave as much information as government censorship would permit. Mr. Clyman spoke briefly of his experiences in newly captured areas of Germany, as a member of an Army Technical Mission which investigated German gas-turbine development. A lively discussion period followed.

Fairfield County Section Guest at Joint Meeting

On Jan. 23 at the Hotel Barnum, Bridgeport, Conn., Joseph Manuele, director of quality control, Westinghouse Electric Corporation, gave a talk on "Quality Control for Industry." The Bridgeport chapter, Society for the Advancement of Management, was host to the Section and to the city chapter of the American Quality Control Society. Brian Mainwaring, vice-president and acting president of the Bridgeport chapter of the Society for the Advancement of Management, served as chairman. Approximately 250 were present. Executives of participating organizations included John F. Banthin, member A.S.M.E., chairman of the Fairfield County Section, and Elson Folsom, chairman, Bridgeport chapter A.Q.C.S.

Electric Gages Subject at Ithaca Section

On Jan. 27 a meeting was held at the Arlington Hotel, Binghamton, N. Y., with 45 present. Hans P. Kuehni of the General Electric Company, gave a talk on "Electric Gages." The speaker said that electric gages take up where the accuracy of mechanical gages stop. He described the four means of actuating electric gages: optics, sound, radiation, and air.

CHARLES L. FAY, SPEAKER AT A.S.M.E. AKRON-CANTON SECTION MEETING

F. G. Tatnall, Speaker at Kansas City Section

On Jan. 15 at the University Club, Kansas City, Mo., an audience of 65 members and 10 guests heard F. G. Tatnall of the Baldwin Locomotive Company, speak on "Physical Testing Up-to-Date and Simplified." Mr. Tatnall emphasized that better engineering will reduce production costs and that the designer, the metallurgist, and the stress analyst would have to work co-operatively. The application of the recently developed strain gages was extensively discussed.

Photographic Division Metropolitan Section Holds Meeting

The Photographic Division of the Section held its second meeting of the season on Jan. 21 in room 501, Engineering Societies Building, New York, N. Y. Norman F. Barnes, section engineer in charge of new developments in the fields of optics, infrared, and color, General Engineering and Consulting Laboratory, General Electric Company, Schenectady, N.Y., spoke on "Color Facts and Fantasies."

One of the most interesting demonstrations consisted of rotating a disk splattered with all kinds of color. At the same time, a stroboscopic light was located directly in front of the rotating disk. By varying the speed of the disk or by varying the speed of the stroboscopic light, many different color combinations could be obtained. Also, if each were held at a certain speed, one definite color would result.

The most remarkable demonstration was the growth of crystals under polarized light. Two or three microscopic slides were shown, which, when heated and placed under polar-

ized light, were perfectly clear. Then, as they cooled off, crystals would grow and show many different colors. Five hundred were present. The chairman of the evening was W. L. Betts of the Bell Telephone Laboratories Inc., and the meeting was in charge of Edward S. Rowell of the Babcock & Wilcox Company.

Mid-Continent Section Hears Talk on Pumping Unit and Pumping Wells

A joint dinner meeting with the Petroleum Engineers of Oklahoma was held on Jan. 22 at the Y.W.C.A., Oklahoma City, Okla., and attended by approximately 120. The subject discussed was the hydraulic pumping unit perfected by the Pelton Water Wheel Division, Baldwin Locomotive Works, San Francisco, Calif., and the speaker was J. F. Kyle of the Baldwin Works. Mr. Kyle's talk was illustrated with slides and provoked an extended series of questions covering all characteristics of the device. Section vice-chairman W. H. Stueve was responsible for A.S.M.E. participation in this meeting.

On Jan. 23 at Tulsa, Okla., 45 members and guests heard D. O. Johnson, member A.S.M.E., of the Johnson-Fagg Engineering Company, Tulsa, Okla., give an illustrated talk on the "Mechanical Problems of Pumping Wells," with special reference to proper weighing and balancing. Mr. Johnson demonstrated some of the field methods used and carried on an open discussion of special problems for more than an hour, following his formal discussion.

Milwaukee Section Honors Past-Chairmen

A dinner meeting was held on Jan. 8 at the City Club, Milwaukee, Wis., at which presentation of A.S.M.E. awards of merit to past-chairmen of the Section was made. Thomas S. McEwan, vice-president, A.S.M.E. Region VI, presented the awards and concluded with a speech of commendation. The technical session featured R. W. Koldermann, manager of the Dow-Corning Chicago office, who gave a talk on the subject of "Silicones." Approximately 90 were in the audience.

North Texas Section Has Joint Meeting

"Water Resources of West Texas," was the subject at the Jan. 29 meeting in the D.P.& L. Building, Dallas, Texas. This was a joint meeting with A.I.E.E. and A.S.C.E. The speaker, Marvin C. Nichols, presented charts and maps showing the gradual drop in static water level over a 20-year period, with the resulting problems encountered in municipal water supply. Ninety-nine were in the audience.

Ontario Section Hears Talk on Die Casting

On Jan. 9 at Hart House, University of Toronto, Toronto, Can., an audience of 75 heard J. C. Griffin, president and general manager, Pressure Castings of Canada, Ltd., speak on "Modern Developments in Die Casting." The speaker gave a general discussion of modern practices in die-casting of zinc, aluminum, and magnesium alloys. The meeting was preceded by a plant-inspection tour of the Pressure Castings of Canada, Limited's, plant at Weston and a dinner at Hart House. A movie was shown entitled "An Introduction to Die Casting."

Courtesy The Milwaukee Journal

T. S. MC EWAN, VICE-PRESIDENT, A.S.M.E. REGION VI, PRESENTS CERTIFICATES OF MERIT TO PAST-CHAIRMEN OF THE A.S.M.E. MILWAUKEE SECTION

(*Left to right:* T. S. McEwan, Robert Cramer, Jr., Theodore Wetzel, Russell Smith, Theodore Eserkaln, and John E. Scheon.)

Home Heating Subject at Plainfield Section

On Jan. 15 at the Elks Club, Elizabeth, N. J., 45 members and 15 guests heard talks on "Development in Home Heating," by T. N. Adlam of the Sarco Company, and W. H. Randolph of the International Heater Company. The speakers gave results with various locations of heating panels; advantages of ceiling and baseboard panels; the requirements for bodily comfort. They also explained the Liverpool Cathedral installation; the continuous-coil versus grid system; and the requirements for control.

Quality Control—Talk at Providence Section

On Jan. 7 in the Providence Engineering Building, Providence, R. I., Clifford W. Kennedy, Federal Products Corporation, gave a talk entitled "Quality Control, Organization, and Methods." Mr. Kennedy asked, "Can management afford to overlook modern quality-control methods?" He said that the use of mathematical formulas, statistics, charts, and inspection records made at properly timed intervals can give information valuable in the operation of quality-control methods and organization to do work right the first time, thereby eliminating scrap. Thirty-one were present.

Dr. Stafford L. Warren at Rochester Section

On Jan. 16 in the Rochester Gas and Electric Corporation's auditorium, Rochester, N. Y., Dr. Stafford L. Warren, professor of radiology, school of medicine and dentistry, University of Rochester, Rochester, N. Y., discussed "Problems Raised by Radioactivity in the Atomic Bomb Program." Dr. Warren explained the use of the Geiger counter for detecting radioactivity aboard the ships and in the waters around Bikini atoll. A film depicting the atomic bomb tests at Bikini was shown, with slides illustrating the effects of radioactivity on mice and fish taken from the Bikini waters. A dinner in honor of the speaker preceded the meeting.

Raleigh Section Meets With N. C. Society of Engineers

On Jan. 24 at the Sir Walter Hotel, Raleigh, N. C., the Raleigh Section joined with the North Carolina Society of Engineers to hear a talk on "Automatic Packaging Machinery for Frozen Foods," by John W. May, member A.S.M.E., chief engineer, Wright's Automatic Machinery Company, Durham, N. C. Mr. May's company is interested in developing automatic machinery of relatively standardized design, preferably in fields in which no machines exist today, to do certain repetitive operations. At present one of the major problems is packaging frozen foods. The Reynolds Metals Company asked to co-operate in the design of automatic machines for producing a metallic container from pure aluminum foil. Mr. May had samples of the aluminum foil that makes up the package. The motion, velocity, and timing problems related were of particular interest to the mechanical engineers. At the conclusion of the talk a moving picture of one of the test runs was shown. This was made in upstate New York under actual operating conditions, and in conjunction with Birds Eye-Snider, Inc. Three hundred were present.

Rock River Valley Hears Talk on Atomic Energy

On Jan. 6 at the Presbyterian Church, Madison, Wis., a joint meeting was held with the Madison Technical Club. Dr. Farrington Daniels, professor of chemistry at the University of Wisconsin, formerly director of the metallurgical laboratory at the University of Chicago, and now consultant on power-production development at Oak Ridge, Tenn., for the Monsanto Chemical Company, spoke on "Atomic Energy." He gave a very interesting and understandable account of fission and how it might be used for power production. The total attendance was approximately 200.

Proposed Legislation Topic at Southern California Section Meeting

In the Rodger Young Auditorium, Los Angeles, Calif., on Jan. 16, Geo. W. Nilsson, representing the Los Angeles Council of the Founders Societies, spoke on "Proposed California Professional Engineers' Act." Mr. Nilsson stated that the proposed Act was approved by all California Sections of the Found-

ers Societies except those of the A.S.M.E. Action, he said, was necessary by February 1, 1947, and copies of the Act were being mailed to members. Over 40 states have such laws, and the speaker said that if we do not act promptly some such legislation will be introduced by irresponsible organizations. Ninety-two were in the audience.

On Jan. 24 a meeting was held on the premises of the Consolidated Steel Corporation, Los Angeles, Calif. F. H. Hough, executive engineer of the Southern California Gas Company, and C. W. Crawford, vice-president, Consolidated Steel Corporation, were the speakers. Mr. Hough explained the economics and design of a 300-million-cu-ft daily gas line, showing the advantages of large-diameter thin-wall high-tensile pipe; lower original cost, maintenance, and operation of line and compressor stations. Mr. Crawford described the design and manufacture of equipment used to produce largediameter pipe incorporating the expansion method which rounds and straightens, tests and cold works, thereby increasing yield strength. One hundred and fifty-one attended the meeting.

Tri-Cities Section Meets With A.S.C.E. and A.S.M.

A joint meeting of the Section with the A.S.C.E. and A.S.M. was held at the Rock Island Arsenal cafeteria, Rock Island, Ill., on Jan. 7. The speaker was J. A. Halley who talked on "Low-Alloy High-Strength Steels." One hundred and five were present.

Material Transportation Discussed at Waterbury Section

A meeting was held on Jan. 15 at the University Club, Hotel Elton, Waterbury, Conn., and the subject discussed was "Postwar Patterns and Problems of Material Transportation," by Charles J. Fagg, president, Newark Central Warehouse. Mr. Fagg expressed appreciation for the opportunity to present to a management-engineering group the problems of the transportation industry. W. W. Weller of Weyerhaeuser Timber Company, and W. H. Ott of Kraft Products, accompanied Mr. Fagg, and ably supported him in the discussion period which followed Mr. Fagg's talk. Fifteen members and 6 guests were present.

Two Speakers at Western Washington Section

The meeting on Jan. 8 at the Engineer's Club, Seattle, Wash., featured talks by Prof. F. K. Kirsten and Thor Henrikson on "Design and Development of Marine Cycloidal Propellers." Professor Kirsten, professor of aeronautical engineering at the University of Washington, inventor of the cycloidal propeller, gave an excellent discussion on the theory and operation of the cycloidal propeller for boats. Thor Henrikson, in charge of research and development for the Pacific Car and Foundry Company of Renton, Wash., told of the recent developments as worked out by his company. One hundred and thirty were in the audience.

Wilmington Sub-Section Hears Talk on Germany

Albert B. Newman, dean of engineering of the College of the City of New York, and vice-president, the American Institute of Chemical Engineers, was speaker at a dinner meeting held by the Wilmington Sub-Section. Dr. Newman has recently returned from Germany where he served for 14 months as chief of the Chemical Industry Section with the Military Government. In his talk, Dr. Newman said that the progress of Germany toward self-sufficiency is being hampered if not threatened by the attention given by the Allied occupation powers to measures restricting any such development. Among the guests were: Dr. C. M. A. Stine, a vice-president and director of the du Pont Company; J. L. Bennett, Hercules Powder Company; J. H. Perry, editor of "The Chemical Engineer's Handbook;" C. H. Chilton, du Pont Company; D. L. Arm, dean of the University of Delaware's school of engineering; and J. I. Clower, head of the mechanical-engineering department at the University.

Brass and Copper Discussed at Worcester Section

On Jan. 23 at the Worcester Polytechnic Institute, Worcester, Mass., a film "Metal of the Ages," was shown. This film was made by the Bridgeport Brass Company and illustrated the melting, rolling, and fabrication of brass and copper. Harold B. Dow, director of public relations of the Bridgeport Brass Company, described the film. Sixty were in the audience.

Student Branches

University of Alabama Branch

At the Jan. 16 meeting two new members were added to the membership committee, Richard Van Hala and Joe Glascock. Mr. Walker, a student member, presented a paper entitled "The Manufacture of Tinplate." Following the presentation of this paper, it was criticized by those present.

MRS. EVELYN KERN KELLY, FORMER STUDENT MEMBER A.S.M.E., COOPER UNION SCHOOL OF ENGINEERING, WHO WAS AWARDED THE BADGE OF DISTINCTION BY THE TAU BETA PI

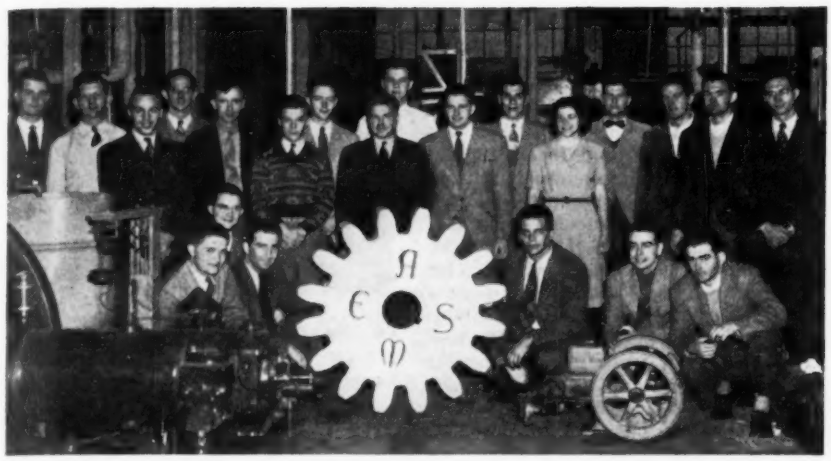
(Recently the local honor society, Mu Alpha Omicron, of which she was a member, became the New York Iota Chapter of the Tau Beta Pi, national honor society for engineers. Because Tau Beta Pi rules bar women from membership, Mrs. Kelly could not be accepted. Instead, she was awarded the society's badge of distinction. Now, as the only remaining member of Mu Alpha Omicron, Mrs. Kelly is a one-woman honor society all to herself.)

Bucknell University Branch

On Dec. 19 the meeting featured talks by two of the 40 undergraduate members of the branch. This was the result of a suggestion made by Prof. John Reed, member A.S.M.E., that emphasis be placed on engineering-student lectures. The first talk was given by Robert F. Sykes who presented an interesting discussion on "Pipe Laying," in which he related difficulties and described how railroad tracks are tunneled, street openings made, and pipes sealed and tested. He illustrated his talk with attractive drawings and sketches. The second talk was given by John B. Clark, entitled "Functions of Naval Ordnance," in which was pointed out the problems involved and calculations required to aim properly a ship's gun emplacement when firing at a moving target. Mr. Clark used colored illustrations and diagrams to illustrate his points.

Carnegie Institute of Technology Branch

On Jan. 14 in the Royal York Apartments, Pittsburgh, Pa., the branch held a banquet for its graduating members. The program included addresses by Professors D. C. Saylor, member A.S.M.E., and T. G. Estep, member A.S.M.E., who explored many aspects of the future of young graduate engineers. A. J. Sullivan, president of the branch, toastmaster, then introduced W. C. L. Trinks, member A.S.M.E., professor emeritus. In his talk Professor Trinks outlined the duties and responsibilities of the mechanical engineer in today's society. He emphasized the need for theoretical development in shop practices. The job, he asserted, belongs largely to the mechanical engineer. Fifty-eight were present.



A.S.M.E. STUDENT BRANCH OF BUCKNELL UNIVERSITY

University of Cincinnati Branch

The first meeting in December, 1946, was omitted, and an engineers' forum held instead. This was sponsored by the branch and the *Co-Operative Engineer*, magazine of the engineering school. The subject of the first forum was "Smoke Elimination." C. F. Hardy, member A.S.M.E., chief engineer, Appalachian Coals, Inc., presented the "Cincinnati Plan;" and the "Pittsburgh Plan" was presented by A. C. Cash, Cincinnati councilman. An open forum followed which was enjoyed by 75 members of the faculty and student body. Future forums are planned.

University of Colorado Branch

On Jan. 8 in the Engineering Administration Building, after a brief business meeting, a talk was given on "Solar Energy" by E. Irish. The speaker told of the utilization of solar energy for practical and heating purposes, explaining that the problem at the present time is in obtaining this energy for such purposes. Mr. Irish brought with him a portable insulation-type collector, similar to the one used at the University by Dr. Löfana in experiments for collecting the energy. Fifty-four were present.

Colorado A.& M. College Branch

The first regular meeting of the second quarter was held on Jan. 13 in the Mechanical Engineering Building, with 20 present. Steven Martino, chairman, conducted a business meeting during which the following new officers were elected to fill vacancies created by resignations: Richard S. Claycomb, vice-chairman; Roberta M. Bartram, secretary; James H. Fischer, treasurer. The preparation of two student papers to be presented at the spring conference to be held at the University of Utah was discussed. Judges will be named to select the two best papers prepared for this competition, with all members eligible. Mr. Martino announced that on Jan. 20 the branch will sponsor a meeting on "Engineering Uses of Atomic Power," at which Dr. Louis R. Weber, head of the physics department, will be the speaker. The program for the evening was an address by Arthur M. Riley, senior mechanical-engineering student, on "Production Control in the Manufacture of 0.30-Caliber Shells at the Denver Ordnance Plant." The subject was well presented and of much educational value.

Cooper Union Institute of Technology Branch

The 23rd Annual Dinner of the Branch which was held in Nikolaus' Chop House, New York, N. Y., was attended by 31 members and 51 guests. Prof. Weller B. Embler, head of the humanities department, was the principal speaker. His theme, "Think as a Man," was highly inspirational and entertaining as well. Herbert Brody acted as toastmaster and introduced Dean G. F. Bateman, member A.S.M.E., who traced the history of the 23 consecutive annual branch dinners, and Robert V. Klint, class of '45, who described the engineering training program at the General Electric Corporation in Schenectady. Prof. H. F. Roemmele, member A.S.M.E., and Tony Peranio, dressed as street musicians, played violin and guitar duets, and Professor Roemmele led the impromptu community sing.

Cooper Union Night School of Engineering Branch

The branch is enjoying its largest membership in several years because of the return of a considerable number of students formerly in the armed services and is resuming many activities necessarily curtailed during the war. Officers elected for the current school year are: Marvin Teitelbaum, chairman; Henry Wald, secretary; Robert Shapiro, treasurer; and

A.S.M.E. STUDENT BRANCH OF THE UNIVERSITY OF COLORADO

Prof. William A. Vopat, member A.S.M.E., honorary chairman.

At the Jan. 13 meeting motion pictures concerning helicopter performance were featured. The films were supplied by the Bell Aircraft and Sikorsky Companies. Additional explanatory remarks were made by Prof. Walter S. Kut, junior member A.S.M.E., who has resumed his teaching duties after a leave of absence in the Naval Air Corps.

Cornell University Branch

On Jan. 7 in Sibley Hall, 75 members and guests heard F. C. Rushing, member A.S.M.E., Westinghouse Electric Corporation, speak on "Vibration and Balancing." A question period followed the talk.

The meeting on Jan. 22 featured F. W. Gottschaulk of the American Lumber Company, who gave a talk on "Resorcinol Adhesives for Laminations for Railroad Bridge Stringers." In spite of the formidable title, this proved a very interesting and understandable talk and was followed by a very active question period with most of the 40 members present taking part.

Drexel Institute Branch

The Jan. 29 meeting in the Drexel Student Building was called to order by John Herman, chairman. He explained the provision of local memberships to students other than seniors so that they can be active in the local branch until October, 1947, at which time national memberships will again be available. The Charles T. Main award was explained and the current topic presented. Kenneth Werner, vice-chairman, notified the members that a joint meeting with the Drexel branch of A.I.E.E. was to be held in the near future. Mr. Aicher of the Yarnall-Waring Company was introduced. He commented briefly on the color-sound film, "There Is an Engineering Reason." The film dealt with boiler-water indicators, alarms, blowoff valves, and related boiler accessories. A brief discussion followed. Fifty-three were present.

Illinois Institute of Technology Branch

The fifth and final meeting of the semester ending Feb. 1 was called to order by Robert Boyar, president, on Jan. 10 in the Illinois Institute of Technology auditorium. H. B. Cole, regional membership chairman, gave a short talk on "Becoming a Junior A.S.M.E. Member." Mr. Cole emphasized the importance of a student's membership in a professional society and the acquiring of knowledge, companionship, and recognition through such membership. A tremendous ovation climaxed the end of the faithful years of service given by Dr. Roland A. Budenholzer, junior member A.S.M.E., honorary chairman. As a token of gratitude the students voted unanimously to award Dr. Budenholzer a gavel. The new chairman is Prof. S. E. Rusinoff, member A.S.M.E., recommended by Robert Boyar, president of the branch, because of his great interest in student activities and affairs. He was unanimously elected. New officers for the spring semester are: Kurt Karl Kuhnle, president; Martin Gabriel, vice-president; Homer Wayne Wickham, secretary; Joseph John Hassler, treasurer.

Iowa State College Branch

At the Jan. 21 meeting in Engineering Hall, after a short business meeting, the members were joined by the Central Illinois Section, A.S.M.E. when a very interesting talk was given by W. G. Lane, coinventor of the Lane-Wells oil-well perforator. In explaining the purpose and mechanism of the oil-well perforator, Mr. Lane used a film and part of the invention. One hundred and fifty were in the audience.

University of Kentucky Branch

At the Jan. 24 meeting in study hall, Engineering College, C. E. Youngblood, chairman, explained the plans of the engineering student council to elect a member of the engineering college as May queen and to stage an all-engineers' dance with a big-name band in the spring quarter. Harold Estill, chairman of the social committee, gave a survey of the different kinds of social functions which might be held by the mechanical-engineering department and it was decided that a vote would be taken at the next meeting to decide what should be done. The speaker was Prof. E. B. Penrod, head of the department of mechanical engineering. Professor Penrod gave a talk on the prospects for mechanical-engineering graduates at the present time. He explained a number of different kinds of engineering positions which are now available, including those associated with design engineering, power-plant engineering, air conditioning, production, research, administration, and sales work. One hundred and sixty-three were present.

DR. MARTIN D. WHITAKER, PRESIDENT, LEHIGH UNIVERSITY, DISCUSSES ATOMIC ENERGY WITH LEHIGH UNIVERSITY STUDENT BRANCH MEMBERS

Lehigh University Branch

On Jan. 16 in the Packard Laboratory the branch sponsored a talk by Dr. Martin D. Whitaker, president of the University, entitled "The Effect of the Atomic Era on Scientists and Engineers." Dr. Whitaker was well qualified to talk on this subject, since he was director of the Clinton Laboratories at Oak Ridge, Tenn., prior to his coming to Lehigh. In his talk Dr. Whitaker stressed the need for properly trained technical men which now faces the atomic-energy industry. Following the talk, Dr. Whitaker continued the subject by answering questions from the audience. The meeting was open to the public, and about 250 students, faculty members, and visitors availed themselves of the opportunity to hear the talk.

Louisiana State University Branch

The Jan. 7 meeting was devoted primarily to the election of officers for the coming semester. Those elected were: Jacob B. Swanson, Jr., chairman; R. J. Meyers, vice-chairman; Salvador Maffei, secretary; John Morrison, treasurer; and Carlos J. Barousse, corresponding secretary.

A banquet was held on Jan. 14 in honor of seniors of the branch who graduated in February. The guest speaker was John Goodman Blanche, Jr., Commander, U. S. Navy, who was one of the naval officers in charge of the atom bomb test. His talk, entitled "Bikini," was a vivid account of the test and although within the bounds of military secrecy, it was interesting and informative. Guests included Dean Leo Joseph Lasalle, college of engineering, mechanical-engineering teachers, and wives of several branch members. Dean Lasalle spoke briefly about the A.S.M.E. Annual Meeting which he attended in December, 1946.

AT THE 23RD ANNUAL DINNER OF THE A.S.M.E. STUDENT BRANCH OF COOPER UNION INSTITUTE OF TECHNOLOGY

Marquette University Branch

The first meeting of the new year was held on Jan. 2 in the Engineering Building. George Elwers, president, explained the special awards and loan service offered the student members of the Society. Applications for enrollment in the national student branch and the local branch were distributed. All of the visitors present, numbering 15, signified their intention of joining the organization.

On Jan. 16 a meeting was held in the Engineering Building when plans were made to organize a bowling team to bowl in the intermural bowling league, and also a bowling party to be given in the near future. Robert H. Woods, junior A.S.M.E., of the Nordberg Diesel Manufacturing Company, was the speaker. His talk was a preparation for the visit to the plant of his company on Jan. 20. Mr. Woods showed slides of different Diesels, their parts and construction. Thirty were present.

University of Maryland Branch

At the December meeting the speaker was J. B. Blaiklock, superintendent of equipment, Capital Transit Company, who gave a talk on "Mechanical Development of the Streamlined Street Car." He covered the suspension, structural, and braking systems in detail and presented graphs to demonstrate changes in acceleration, maximum speed, and weight per passenger over a period from 1920 to 1940.

On Jan. 15 a joint meeting of the U. of M. engineering societies was held. Jeff Nairn, president A.S.C.E. branch, presided. Plans were discussed for resumption of the Engineers' Council and the possibility of an Engineers' Day and dance. Dean Steinberg, college of engineering, furnished the assembly information as to the assets and functions of the Council.

J. E. Younger, member A.S.M.E., head of the mechanical-engineering department, addressed the audience on mechanical and aeronautical engineering. He expressed the opinion that the backlog need for mechanical engineers would continue beyond the graduation of the present freshman class. He also discussed the relative need for various types of engineers in different industries. Upon completion of his speech, Dr. Younger was recalled to the platform by Mr. Bank, vice-president of the A.S.M.E. branch, and presented with a cowhide leather brief case, a gift from the members of the U. of M. branch. In accepting the gift, Dr. Younger expressed his deep regret at leaving the University and his numerous friends among the students and faculty. He is leaving at the end of this semester to accept a position in Brazil. Two hundred and twenty-five were at the meeting, and after a discussion session, refreshments were served to 500 members and guests. At that time a film on lubrication was presented.

Massachusetts Institute of Technology Branch

The last meeting of the fall term was held on Jan. 17 with 35 members present. The present chairman, R. F. Miaskiewicz, graduates in February, and the vice-chairman, G. Richard Turner, and secretary-treasurer, Edward H. O'Brien, asked to be relieved of their duties because of heavy school work. Therefore an election was held which resulted as follows: Soli Dadabhoy Dubash, chairman; Harold B. Hirsch, vice-chairman; and Edward C. Ristner, secretary-treasurer.

Montana State College Branch

The meeting on Jan. 15 in Roberts Hall was called to order by the chairman, Robert Anspach. It was decided that the branch would not spend the required $40 for a picture in the *Montanan*. Plans were made for a meeting on Feb. 28 jointly with other engineering societies on the campus. A movie on plastics was shown.

On Jan. 29 a talk was given by Frank Hoey of the Bozeman Sheet Metal Works. Mr. Hoey told of the evolution of the stove from a mere camp fire to the present warm-air-conditioning units. A general discussion was held on the possibilities of jobs for young engineers. Students from other engineering-society branches were guests, and the total attendance was 40.

University of Nebraska Branch

The final meeting of the first semester was held in Richards Laboratory on Jan. 15. New officers elected to serve during the second semester are: Geral W. Jones, chairman; Duane A. Schmeeckle, vice-chairman; Charles R. Patton, treasurer; and James K. Jensen, secretary. Professor Ludwickson, member A.S.M.E., honorary chairman, gave a talk on the benefits to the graduate engineer in becoming a junior member in the A.S.M.E. Colored slides of Germany and Austria, and the Colorado Rockies were shown.

University of New Hampshire Branch

On Jan. 27 a meeting was held in the trophy room of Commons Dormitory. The guest speaker was C. E. Davies, secretary, A.S.M.E. Mr. Davies gave an interesting talk concerning the purposes of the organization and told of current activities and plans now in progress. He stressed the importance of young engineers taking an active part in the Society. Mr. Davies also explained how the Society could help the growth of a young man out of college and emphasized the fact to the seniors that their education was just beginning. Fifty-five were present.

Northeastern University Branch

Election of officers for the new school year was held on Jan. 8 in room 300, Richards Hall. The following new officers will serve for the next semester: Leon W. Rank, chairman; F. J. Callahan, vice-chairman; Oscar J. Marchand, secretary; Ernest R. Blair, treasurer;

A.S.M.E. UNIVERSITY OF NEBRASKA STUDENT BRANCH

A.S.M.E. OKLAHOMA A.& M. COLLEGE STUDENT BRANCH

F. F. Fabio, social chairman; August Ventre, publicity chairman; and R. Clark, program chairman.

At the Jan. 15 meeting in the Student Union Room, John McManus, program chairman, introduced the guest speaker, Frederick S. Bacon, manager of the Central Stations Division, Westinghouse Electric Corporation, and vice-president of the Massachusetts Society of Professional Engineers. His topic was "The Engineer and His Future."

Oklahoma A.& M. College Branch

A meeting was held on Jan. 12 in the Engineering Auditorium with 51 present. Philip S. Donnell, former dean of engineering, was the guest speaker. His topic was "World Affairs." Chairman Ray Porter again urged that all members prepare papers to be given before the branch and announced that cash awards would be given for the three best papers presented. These papers would also be presented at the next Regional meeting.

Pennsylvania State College Branch

On Jan. 9 C. E. Davies, secretary, A.S.M.E., spoke to the branch on the subject "Whither Engineering?" Several of the current trends in engineering were discussed. Mr. Davies brought out the current problem with which the engineer is occupied—collective bargaining in engineering. He discussed the engineer's place in international events and also dealt with the question of combining, or at least coordinating, the efforts of the various engineering societies; he emphasized the fact that any change that might take place would have to be through evolution rather than revolution. Mr. Davies then told of the steps the A.S.M.E. was taking in this direction. Dr. H. P. Hammond, member A.S.M.E., dean of the engineering school, entered into discussion with Mr. Davies on this point. The meeting closed with a general discussion in which the audience of 65 joined. After the meeting a photograph was taken of the officers of the branch.

Purdue University Branch

The Jan. 22 meeting in the Mechanical Engineering Building, featured Dr. Irving Burr of the Purdue mathematics department, who gave an interesting talk on "Management's Use of Statistics." After a short résumé of the history of statistics, Professor Burr pointed out how statistics are on hand in practically all types of manufacture, but yet many industries fail to use them. Examples of how trouble in a process is spotted and then how to find the assignable cause from the statistics on the product were given. He also demonstrated the use of the statistical control chart to set economical limits of tolerances for the production of a certain item and how to check on the quality of the finished product to determine the amount of inspection necessary.

Rensselaer Polytechnic Institute Branch

A meeting was held on Dec. 18 in the Sage Building, with 50 members and 25 guests present. Edwin Wineberg, chief engineer of the Ludlow Valve Company, Troy, N. Y., was the guest speaker. He gave an interesting talk on valves and explained the various types, respective purposes, and methods of construction and manufacture. He accompanied the talk with slides to illustrate all types of valves and their installation. A question-and-answer period followed. A report was given by Eugene Zak on the A.S.M.E. Annual Meeting in New York, to which the branch sent 3 representatives.

South Dakota State College Branch

The Dec. 9 meeting in the Engineering Building was called to order by chairman Eugene Case. A report on membership by Tom Crusinberry showed that the branch now has 24 members. George Patterson was elected chairman of the program committee for the second general engineers' meeting. His assistant is Tom Crusinberry. The program was a technicolor movie on North American wild life which was shown as a substitute for a film

OFFICERS OF THE A.S.M.E. STUDENT BRANCH AT PENNSYLVANIA STATE COLLEGE

from an engineering company which did not arrive in time.

University of Southern California Branch

The meeting on Jan. 9 in the Cinema Building was called to order by Henry A. Hoste, chairman. Prof. E. K. Springer, member A.S.M.E., faculty adviser, reminded the members of the student papers to be given at a Regional meeting in Berkeley, Calif. Winners will receive triplicate prize money from Berkeley, the A.S.M.E. Los Angeles Section, and from the student branch at the University of Southern California. Election of officers will be held at the next meeting, and arrangements for transportation to the field-trip inspection of the Firestone Rubber Company's plant were completed. A movie, "The Building of a Tire," completed the program.

Stevens Institute of Technology Branch

The branch members met with the Stevens Engineering Society members on Jan. 10, at a smoker, to hear John I. Yellott, member A.S.M.E., director of research, Locomotive Development Committee, Baltimore, Md., discuss the development and use of jet and gas-turbine engines. Mr. Yellott explained the design of the two main types of jet engines—the "Whittle" and axial-compressor units.

He mentioned another new type of airplane power, the "Prop-jet." This can be used up to speeds of 500 miles per hour, after which the propeller ceases to function and becomes a hindrance. Mr. Yellott also explained the use of gas turbines in the railroad industry and said that when made with special high-temperature alloys they are about 28 per cent efficient. Two other short talks were given by A. R. Mumford, vice-president, A.S.M.E. Region II, who spoke on the work of the Society, and by Rudolph Gagg, member A.S.M.E., who described the various opportunities awaiting graduate engineers.

University of Texas Branch

The last meeting of the winter semester was held on Jan. 8 in room 138, Engineering Building. Officers were elected for the spring semester as follows: S. E. Kuenstler, president; R. C. Brooks, vice-president; J. C. Andrews, secretary. Following the election, Harry R. Pearson, member A.S.M.E., a graduate of the University of Texas, and now personnel director of the Dallas Power and Light Company, gave a talk entitled "The Engineer's Place in Personnel Relations."

DEC. 9 MEETING OF THE SOUTH DAKOTA STATE COLLEGE STUDENT BRANCH

A.& M. College of Texas Branch

On Dec. 3, 1946, the branch joined with all other technical organizations on the campus to hear a talk given by W. W. Findly of the Guiberson Corporation, Dallas, Texas, on "National Preparedness." The speaker was introdeced by H. W. Barlow, dean of engineering. Mr. Findly gave a history of the difficulties encountered in national preparedness during World War II, stressing the conversion from peacetime to wartime production and listing the time required for conversion at about two years. In the next war, he said, the United States would not have this long period for conversion, and therefore the only solution, he believed, is to construct plants and factories and run them at full production through all the years of peace, so that when or if war may come we will be prepared. He further stated that he believed if the United States is constantly prepared there will be no major conflict. Mr. Findly added that we should not consider this method as a means to waste money but as a form of insurance on our country and inhabitants. A discussion period followed the talk. Nine hundred were present.

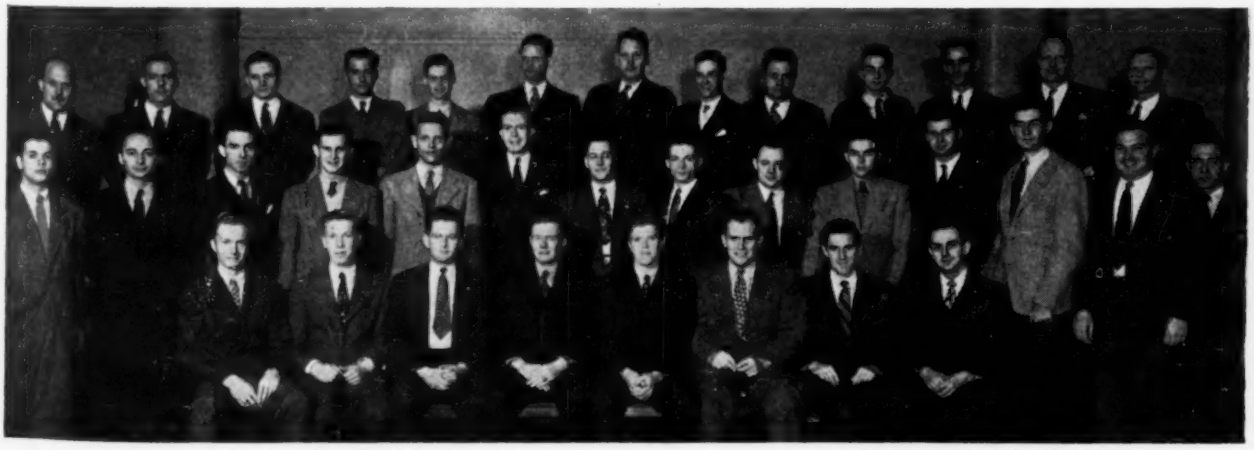
Virginia Polytechnic Institute

The first meeting of the current quarter was held on Jan. 13 in Patton Engineering Hall. The members were welcomed by the president, Otey M. Glass. A.S.M.E. charms and pins were distributed to new members. The program consisted of two sound films, "Building a Bomber," and "The Tremendous Trifle." One hundred and fifteen were present.

The branch is proud of its attendance during the past quarter and at the beginning of the present quarter. At least 100 have attended each meeting held the last quarter, the figure approaching 200 for several meetings. At the Jan. 20 meeting 212 students signed attendance cards, and there were more than 100 chemical-engineering students present. The branch has over 65 members solicited or already members, and a total of over 165 national and local student members on roll.

Washington State College Branch

A regular meeting was held on Jan. 16 in the Mechanical Arts Building. Chairman Pat O'Neil announced that the branch had made arrangements for a half page in the college publication "*Chinook*" and a picture of the members will be published there. Winners of papers entered in the local contest this coming spring will be entered in the Sectional contest



A.S.M.E. STUDENT BRANCH OF THE STEVENS INSTITUTE OF TECHNOLOGY

in Spokane, Wash., in May. This was the last meeting of the current semester.

West Virginia University Branch

The branch meets once a week in a regularly scheduled course called "Engineering Society." Students give 5-minute papers on subjects of interest to engineers. Each student gives two papers a semester and receives a grade with one-half semester-hour credit. Once a month the branches of all the engineering societies hold a joint meeting for which an outside speaker is obtained. Each branch takes its turn in arranging the program. At present the branch numbers 40 members. The officers are: F. M. Flanigan, president; A. L. Clark, vice-president; and J. I. Reynolds, honorary chairman.

A.S.M.E. Sections

Coming Meetings

Birmingham: March 17. Tutwiler Hotel, Birmingham, Ala., at 8:00 p.m. Subject: "Manufacture and Application of Wire Rope," by David Larkin, vice-president, Broderick and Bascom Rope Company, St. Louis, Mo.

Boston: March 21. Commander Hotel, Cambridge, Mass. Dinner at 6:30 p.m.; meeting at 8:00 p.m. Subject: "Use of Power in the Paper Industry," by R. R. Baker, paper mill application engineer, Westinghouse Electric Corporation, Pittsburgh, Pa.

Cincinnati: March 6. (Meeting has been assigned to the Student Branch of the University of Cincinnati for them to originate and put on a students' program.)

Fairfield County: March 19. Hotel Barnum, Bridgeport, Conn. Dinner at 6:30 p.m.; meeting at 8:00 p.m. Subject: "Personal Flying—Light Planes and Airports," by W. T. Piper, president, Piper Aircraft Corporation, Lock Haven, Pa.

Ithaca: March 31. Arlington Hotel, Binghamton, N. Y., at 6:30 p.m. Subject: "Some Practical Aspects of Automatic Control," by W. H. Steinkamp, assistant general sales manager, Brown Instrument Company, Philadelphia, Pa.

Metropolitan: New Jersey Division. March 5. Essex House Hotel, Newark, N. J., at 7:45 p.m. Subject: "Jet Propulsion of Aircraft," by R. J. Rettaliata, Illinois Institute of Technology, Chicago, Ill.

March 13. Woman's Auxiliary. March 13. Engineering Woman's Club, 2 Fifth Ave., New York, N. Y. Annual Bridge Party, Benefit Calvin W. Rice Scholarship and Student Loan Fund, Luncheon, Entertainment, and Prizes.

March 18. Junior Group. Room 502,[1] New York, N. Y., at 7:30 p.m. Subject: "Development of the Engineer in Industry," by George Hamson and Fred Huntington, of the Booz, Allen, and Hamilton.

March 19. Photographic. Room 1101.[1] Subject: "Photographic Lenses," by E. M. Bechtold, Columbia University, New York, N. Y.

March 21. Industrial Instruments and Regulators. Room 501A,[1] New York, N. Y., 7:30 p.m. Subject: Seminar "Hydraulically Operated Servomechanisms," by Representative of Vickers Company, Inc.

March 24. Management. Room 502,[1] New York, N. Y., at 7:30 p.m. Subject: "Labor Relations—Problems in Making Collective Bargaining Work—A discussion of the role of Management—Unions and Government in the Collective Bargaining Procedure," by J. P. Mitchell, R. H. Macy and Company, New York, N. Y.

March 27. Room 1101, Engineering Societies Bldg., New York, N. Y., at 7:30 p.m. Forum "How Does the Metropolitan Section, A.S.M.E. Work?"

Mid-Continent: March 27. Mayo Hotel Tulsa, Okla., at 8:00 p.m. Subject: "Practical Methods and Technical Problems in the Use of Aluminum Shapes in Portable Oil-Field Equipment," by George Perkins, director of technical research division, Reynolds Metals Company.

Minnesota: March 24. Wold Chamberlain Airport, Minneapolis, Minn., at 7:00 p.m. Inspection trip to examine new four-engine Boeing Stratoliner to be put into service by Northwest Airlines.

New Haven: March 12. (Place of meeting to be announced later.) Subject: "The Coal-Burning Gas Turbine," by John I. Yellot, Bituminous Coal Research, Inc., Chicago, Ill.

Philadelphia: March 12. Subject: "Radar and Its Applications." (Speaker to be announced.)

March 17. Joint Meeting With Professional Engineers' Club—Carteret Club.

March 18. Subject: "Industrial Instruments." (Speaker to be announced.)

March 19. 12:00 noon, "An Hour With Kipling," by M. H. Nichols.

March 25. Subject: Aviation. (Speaker to be announced.)

Pittsburgh: March 4. William Penn Hotel, Pittsburgh, Pa., at 8:00 p.m. Joint Meeting With the Engineers' Society of Western Pennsylvania. Subject: "The Planning and Development of an Electric Power System," by K. M. Irwin, manager, engineering department, Philadelphia Electric Company, Philadelphia, Pa.

Providence: March 4. Providence Engineering Society Building, 195 Angell St., Providence, R. I., at 8:00 p.m. Subject: "Engineers Against War—A Practical Program of Peacetime Patriotism," by Col. James L. Walsh, president, Army Ordnance Association, New York, N. Y.

Rochester: March 13. Hotel Sheraton, Rochester, N. Y., at 8:15 p.m. Subject: "Gasoline, Yesterday, Today and Tomorrow," by T. A. Boyd, head, fuel department, Research Laboratories, Division of General Motors Corporation, and vice-president, A.S.T.M.; and also "Progress in Rubber," by B. P. Ressinger, field engineer, The B. F. Goodrich Company, Akron, Ohio.

[1] Engineering Societies Building, 29 West 39th St., New York, N. Y.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	212 West Wacker Drive	109 Farnsworth Ave.	57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, age 37; excellent record as power superintendent and maintenance engineer by developing and applying preventive-control procedure applicable to all industrial-plant equipment. Broad experience in labor relations. Can assure appreciable saving by making planned operation and maintenance possible. Starting salary $8000 to $10,000 with opportunity. Me-148.

MECHANICAL ENGINEER; B.S.M.E., 38; family; 13 years' experience; plant engineer for large company manufacturing food products and edible oil; milling and refining. Experience with most types of food-processing equipment. Considerable time spent in research and process development and interested in this work. Me-149.

MECHANICAL ENGINEER, aeronautical option, graduate; 10 years' diversified experience; machine-tool design; aircraft-propeller-vibration research; officer at Wright Field, engineering division, equipment laboratory in supervisory capacity; desires connection in sales or development. Me-150.

[1] All men listed hold some form of A.S.M.E. membership.

MECHANICAL ENGINEER, B.M.E., design and shop background. Experience: marine piping and installations; research, design, and testing aircraft hydraulic systems and accessory equipment. Navy training and experience in electronics. Metropolitan area preferred. Me-151.

CREATIVE MECHANICAL ENGINEER: Ideas developed for new products or new applications for present products investigated. Interested in company willing to invest in advertising promotion to get quick results. Formerly with largest manufacturer of small radios. Me-152.

POSITIONS AVAILABLE

PROJECT MANAGERS, graduate mechanical engineers to take over complete job of laying out and installing vacuum processing installations ranging in cost from $150,000 to $300,000. Field includes tobacco-processing machinery, mash coolers for distilleries, etc. Applicants should be familiar with thermodynamics, steam engineering, hydraulics, layout work, piping, and conveyers. Position permanent. Location, Chicago. $4800–$6000. R-3950-C.

SENIOR ENGINEERS. (*a*) Servomechanisms, hydraulic, pneumatic, electric. (*b*) Gyromechanisms and other instrumentations. (*c*) General mechanical component design, airborne radar. Several years' commercial experience in one or more of foregoing, good educational background. Large guided-missile program. All phases, study, research, development, product design for production. Positions offer permanence, top salaries, and opportunities for increased responsibility for men who can produce. Massachusetts. B-1199.

MINING OR MECHANICAL ENGINEER, 40–45, with at least 10 years' experience as master mechanic in charge of mining, milling, and Diesel power equipment, to take charge of installation and supervise operation on large mining project. $7200–$7800 year. Africa. W-8437.

EQUIPMENT DESIGN ENGINEER, 35–50, mechanical graduate from recognized engineering school, with design experience in some form of automatic machinery and experience in production of comparable equipment. $6000–$7200 year. Connecticut. W-8443.

MECHANICAL DRAFTSMEN experienced in piping or tank-design work for water for conditioning company. $3900–$4200 year. Northern New Jersey. W-8469.

ENGINEERS, preferably with knowledge of textiles. (*a*) Mechanical engineer to design and lay out boiler plant and humidification projects and do some machine design, etc. Should be capable draftsman. (*b*) Textile draftsman and engineer to lay out machinery and make careful studies of efficient layout of such machinery. (*c*) Plant engineer with construction and maintenance experience for general plant engineering and maintenance, including carpentry, plumbing, heating, etc. (*d*) Electrical-layout engineer to design and lay out overhead transmission lines, transformers, switchboards, and distribution lines in textile mills. Salaries open. North Carolina. W-8481.

SALES ENGINEERS for water-treatment-equipment concern. (*a*) Sales manager with chemical background and at least 10 years' experience; capable of managing nation-wide organization. (*b*) Sales engineers, young, with chemical background, for sale of such equipment. Write giving education, experience, salary desired, age, etc. New York metropolitan area. W-8485.

ENGINEERS. (*a*) Gas superintendent experienced in manufacture and distribution of gas, using Jones Oil Gas Process or equivalent. Experience in distribution and customer relations desired. (*b*) Mechanical engineer, young, with good engineering background and experience in mechanical practices, including public-utility power plant, to assist with mechanical problems in office and field. (*c*) Electrical engineer, young, with good background, to assist in office and field on electrical-distribution problems. (*d*) Telephone superintendent capable of taking complete charge of conversion from common-battery manual system to automatic-dial operation, services, customers' instruments and with experience in this type of work. Salaries open. Write giving education, experience, and references. Central America. W-8501.

ENGINEERS. (*a*) Design and process engineer for manufacturer of display boxes. Should be able to create, design, and make new samples and also to specify the process to be followed from the standpoint of manufacturing, i.e., the easiest, cheapest, quickest way. Should be acquainted with equipment used; study processes; recommend improvements. Must have experience in manufacture of paper, cardboard, and wood boxes. Some experience in cloth or leather goods would be acceptable. (*b*) Plant superintendent experienced in paperbox business. Must know various machines and equipment and be able to obtain maximum use of machinery and equipment involved as well as man power involved. Plant has about 150 employees. $3600–$5200 year. East. W-8505.

PROFESSOR OR ASSOCIATE PROFESSOR capable of teaching undergraduate and graduate courses in aircraft propulsion. Must have good academic training and teaching experience. Will have supervision of entire aircraft-power-plant-course program. Permanent. Write giving education and experience. Salary and rank dependent upon qualifications. Maryland. W-8540.

ENGINEERS. (*a*) Vice-president and general manager, 40–50, engineering or business-administration graduate from recognized engineering school, with experience in fiberboard manufacture. This experience necessary. $15,000–$20,000 year. (*b*) Plant superintendent, 38–45, also with experience in manufacture of fiberboard. $10,000–$13,000 year. Western New York. W-8581.

CHIEF ENGINEER for completely integrated iron and steel plant to be built out of country. Would be located in New York for about 2 years where he would be in charge of engineering offices and then later be out of country for 3 years or more. W-8583.

ENGINEERING INSTRUCTION. Master's degrees or industrial experience desired. (*a*) Assistant or associate professor of electrical engineering, 30–40, to teach a-c circuits and machines. Position starts July 1, 1947. (*b*) Instructor or assistant professor of civil engineering, 25–40, to teach surveying, materials testing, soil mechanics. Position starts October 1, 1947. (*c*) Instructor of mechanical engineering, 25–30, to teach engineering drawing and possibly other courses. Position starts October 1, 1947. New England. W-8587.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after Mar. 25, 1947, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Fellow, Member, Associate, or Junior

ANDERSON, M. C., Houston, Texas
ARMSTRONG, JOHN B., Wilkes-Barre, Pa.
BALDWIN, EDWARD N., State College, Pa. (Rt & T)
BENNETT, WILLIAM GORDON, JR., New York, N. Y.
BERG, CLYDE, Wilmington, Calif.
BERNSTEIN, IRVING, Hartford, Conn.
BISSETT, J. R., Savannah, Ga.
BLAKE, A. HAROLD, Salt Lake City, Utah (Rt & T)
BOLLINGER, GEORGE W., Queens Village, N. Y. (Rt & T)
BONVILLIAN, C. A., Chattanooga, Tenn.
BROOKS, R. H., JR., Tulsa, Okla.
BROZ, FREDERICK J., Lakewood, Ohio
BURKE, RICHARD L., JR., Hastings-on-Hudson, N. Y.
BUSKE, G. E., Eau Claire, Wis. (Re)
CAUFIELD, WALLACE B., London, England
CESAR, EDISON M., New York, N. Y.
CHRISTENSEN, R. W., Chicago, Ill.
COLEMAN, ARTHUR F., New York, N. Y.
COLIBRARO, DANIEL, Casper, Wyo. (Re)
CONKLIN, W. H., San Marino, Calif.
COOPER, SAMUEL E., Dearborn, Mich.
DAGUE, BYRON S., Gainesville, Fla.
DANIEL, KENNETH R., Homewood, Ala. (Rt & T)
DAVIDSON, EUGENE S., Brooklyn, N. Y.

DEAN, S. M., Detroit, Mich.
DI SANTIS, VICTOR T., Erie, Pa.
DRANE, PHIL B., Tulsa, Okla.
DUERKSEN, ARNOLD, Lodi, Calif.
ELLSWORTH, GEORGE, Louisville, Ky.
EMERSON, E. March, Cambridge, England
EUSTICE, J. H., Tulsa, Okla.
EVANS, FREDERIC C., Edge Moor, Del. (Rt & T)
FISKEN, A. D., Toronto, Ontario, Can.
FOSHOLT, S. K., Muscatine, Iowa
FULLER, L. E., JR., Chicago, Ill.
GETLINE, GORDON L., Dayton, Ohio
GILMORE, STANLEY, New Lenox, Ill.
GOSSLING, C. E., Winnipeg, Manitoba, Can.
GREENLAND, J. A., Seattle, Wash.
GREYSON, R. D., Santa Monica, Calif.
GROOM, CLAUDE H., Tulsa, Okla.
GUARDA M. H., Reumen, Chile
GUDMESTAD, RAGNAR, Milwaukee, Wis.
GUY, RICHARD D., National City, Calif.
HANNERS, HARVEY W., Springfield, Mass.
HARCOURT, GUY N., Buffalo, N. Y.
HARINGX, J. A., Eindhoven, Holland
HAYES, THOMAS B., Corvallis, Ore.
HELTON, EUGENE L., Peoria, Ill.
HIRSH, WAREEN LEE, South Orange, N. J.
HOLLAND, CYRUS E., Highland Park, Ill.
HUTCHINSON, R. C., Fort Collins, Colo.
HYLER, JOHN H., Peoria, Ill.
JOHNSON, HERBERT A., Providence, R. I.
KIRKUP, BENJAMIN C., Port Washington, N. Y.
KOVACS, C. EDWARD, Seattle, Wash.
KUPHAL, R. M., Connersville, Ind.
LAPP, ROGER H., Jeannette, Pa.
LARLEE, DANIEL H., New Hyde Park, N. Y.
LARSEN, MORTON C., Salt Lake City, Utah
LAYSON, W. G., JR., Chattanooga, Tenn.
LAYTON, J. E., Clarendon Hills, Ill.
LIVERMORE, DONALD F., Schenectady, N. Y.
LLOYD, GRIER, Chattanooga, Tenn.
LOHR, JAMES A., Indianapolis, Ind.
LORING, HERBERT F., New York, N. Y. (Rt & T)
LOUDIN, HAROLD H., Newark, Ohio
LOWE, S. C., Montreal, Quebec, Can.
LYMN, D. E., Birmingham, England
MAC CHEYNE, G. W., Geneva, N. Y.
MALLOY, EDWIN SITGREAVES, New Brunswick, N. J.
MANGINI, FRANCIS A., JR., Flushing, N. Y.
MARKEL, FRANK E., Atlanta, Ga.
MCINTOSH, KENNETH B., Baltimore, Md.
MCMEEN, HARRY H., Harvey, Ill.
MCNAIR, ROBERT E., Swarthmore, Pa.
MEYER, WILLIAM M., III, Cheshire, Conn.
MIRSHAK, LOUIS, Dover, N. J.
MOORE, JOHN H., St. Paul, Minn.
MOSHER, ERNEST J., Washington, D. C.
NEAL, ROY OTLEY, Tulsa, Okla.
NELSON, GEORGE A., San Francisco, Calif.
OLSON, RAY T., Kentfield, Calif.
PARKERSON, T. B., JR., Los Angeles, Calif.
PETERSON, RAYMOND C. W., Toledo, Ohio
PICKERING, CHARLES H., Rockville Centre, N. Y.
POPE, JOHN H., Rossville, Ga. (Re)
POPHAM, RICHARD R., New York, N. Y. (Rt & T)
PUGH, D. CLARK, South Charleston, W. Va.
REBER, R. J., Baden, Switzerland
RENTZ, WILLIAM K., Berkeley, Calif.
ROEBUCK, A., Sheffield, England
SALEH, M., Cairo, Egypt
SANDERS, A. L. R., Chicago, Ill.
SANDERS, W. B., West Lafayette, Ind.
SCHIERLAND, RAYMOND F., Cincinnati, Ohio
SCHULER, WILLIAM C., Rahway, N. J.
SCHULTE, CHARLES A., Buffalo, N. Y.
SELBY-HELE, ROBERT H., Victoria, Australia
SICHERMAN, HAROLD L., Cleveland, Ohio (Re)
SIEBERT, EDMOND A., JR., Chicago, Ill.
SINGH, MOHINDAR, Punjab, India
SMELKER, JAMES W., Columbus, Ohio
SMITH, W. E., North Harrow, Middlesex, England
SPEAR, P., Birmingham, England
STAFFORD, W. H., Charleston, W. Va. (Rt & T)
STRIKER, R. C., Detroit, Mich.
SUMMERFIELD, MARTIN, South Pasadena, Calif.
SWARTZELL, KEITH L., Brooklyn, N. Y.
SWOYER, ROBERT H., Allentown, Pa.
TERRY, T. RANKIN, Lexington, Ky (Rt & T)
TOBEY, SOLOMON, Philadelphia, Pa.
TOLL, MARTIN S., Stratford, Conn.
TOWNSEND, C. H., Toronto, Ontario, Can.
TYLER, D. O., Buffalo, N. Y.
UDALL, FREDERICK M., New York, N. Y.
VENABLE, PAUL C., Arlington, N. J.
WAGNER, RICHARD L., Packanack Lake, N. J.
WALK, FRANK H., Baton Rouge, La.
WALKER, HENRY L., Poughkeepsie, N. Y.
WATTS, SHERMAN S., Phillipsburg, N. J.
WEIS, ELMER JACK, Huntington Park, Calif.
WELCH, A. WILLIAM, Weymouth, Mass.
WETZLER, JUSTIN J., Chicago, Ill.
WEYER, HENRY A., Chambersburg, Pa.
WEYL, ERIC, Manchester, N. H.
WILKIE, ROBERT C., Andover, Mass.
WILLKIE, H. F., Louisville, Ky.
WILSON, EVERITT W., Kenvil, N. J.
WILSON, JOHN, Hamilton, Ontario, Can.
WILSON, M. J., New South Wales, Australia
WINNE, DAVID H., Rexford, N. Y.
WOHLGEMUTH, M. J., Pittsburgh, Pa.
WYBLE, JEROME B., Washington, D. C.
YOUNG, BRUCE A., Detroit, Mich.
ZUPEZ, JOHN A., St. Louis, Mo.

TRANSFERS TO FELLOW

SPENCER, C. G., New York, N. Y.
VAN BRUNT, JOHN, Flushing, N. Y.

TRANSFERS TO MEMBER

BALLEISEN, CHARLES E., West Lafayette, Ind.
BEYNON, C. E., Deep River, Ontario, Can.
BOCHENEK, ALFRED F., Summit, N. J.
COLE, ROBERT W., Attleboro, Mass.
DEIST, HERBERT H., Akron, Ohio
FIALA, SIGMUND N., Nutley, N. J.
GEGAN, AMBROSE J., JR., Atlanta, Ga.
GERLA, MORTON, Forest Hills, N. Y.
ILLASZEWICZ, J., Parent, Quebec, Can.
ILLES, S. R., Cleveland, Ohio
INGRAM, GEORGE, JR., New York, N. Y.
KIMBALL, HENRY B., Beverly, Mass.
LEBO, WILLIAM H., Kansas City, Mo.
LEWIS, ORVAL, Tulsa, Okla.
LYNCH, THOMAS F., Potrerillos, Chile
MEYERHANS, ROBERT H., Bloomfield, N. J.
MILLS, W. E., Ocean Falls, B. C., Can.
MOELLER, ROBERT, Bethesda, Md.
ROBERTSON, A. M., New York, N. Y.
ROBERTSON, E. N., Newton, Pa.
SANDOWSKI, WLADYSLAW, Hammond, Ind.
SCHEIB, LOUIS, Brooklyn, N. Y.
SCOTT, ROBERT S., New York, N. Y.
STRAHL, O. ROBERT, North Bergen, N. J.
TORLEY, J. F., Sharon, Pa.
TRUETT, B. S., San Francisco, Calif.
WEBER, L. JOE, Bartlesville, Okla.
WHITT, SIDNEY A., Yonkers, N. Y.

Transfers from Student Member to Junior.....55

Necrology

THE deaths of the following members have recently been reported to headquarters:

ARNOLD, DEWITT R., December 21, 1946
ASSAYKEEN, IVAN V., January 8, 1947
BURROWS, ROBERT J., January 12, 1947
CORNELL, HARRY L., June 25, 1946*
GRIMISON, EDWIN D., January 11, 1947
HEALY, JOHN M., October 26, 1946
HERMANN, CLARENCE C., January 20, 1947
HUFFMAN, C. A., November 18, 1946
MACNAMARA, M. J., October 24, 1946
MCKEE, THOMAS C., December 30, 1946
MCNEW, JOHN T. L., December 21, 1946
MITCHELL, HARRY, December 21, 1946
MIXTER, GEORGE W., January 29, 1947
NEFF, JOHN P., January 17, 1947
SHONNARD, HAROLD W., March 2, 1946
TIMMONS, JOHN J., December 13, 1946

*Died in line of duty.

A.S.M.E. Transactions for February, 1947

THE February, 1947, issue of the Transactions of the A.S.M.E. contains the following papers:

TECHNICAL PAPERS

Fracture of Some Aluminum Alloys Under Combined Stress, by E. G. Thomsen, D. M. Cunningham, and J. E. Dorn

Airplane Quieting I—Measurement of Sound Levels in Flight, by L. L. Beranek and H. W. Rudmose

Airplane Quieting II—Specification of Acceptable Noise Levels, by L. L. Beranek

Terminal Velocity as the Measure of Dust-Particle Characteristics, by R. B. Foley

Latest Developments in Aircraft Controls and Instrumentation, by R. A. Brown

Influence on Tool Life and Power of Nose Radius, Chamfer, and Peripheral-Cutting-Edge Angle When Face-Milling a 40,000-Psi Cast Iron, by O. W. Boston and W. W. Gilbert

Results of an Investigation of the Removal of Metals by the Process of Grinding, by R. E. McKee, R. S. Moore, and O. W. Boston

Trends in the Development and Application of Cutting Fluids, by J. T. Beard, Jr.

Effect of Spacing Between Dies in the Tandem Drawing of Tubular Parts, by George Sachs and George Espey

Experiences With Automatic Air Soot Blowers at the Oswego and Charles R. Huntley Steam Stations, by H. L. Smith

The High-Frequency Heating of Nonconducting Materials, by F. J. Jolly

The Application of Wood and Fiber to Industrial Packing, by J. A. DeLuca